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REPORT OF THE CHIEF OF THE BUREAU OF BIOLOGICAL SURVEY, 1934

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF BIOLOGICAL SURVEY,
Washington, D. C., August 31, 1934.

SIR: I present herewith the report of the Bureau of Biological Survey for the fiscal year ended June 30, 1934.[1]

J. N. DARLING, *Chief.*

HON. HENRY A. WALLACE,
Secretary of Agriculture.

INTRODUCTION

REORGANIZATION OF THE BUREAU

Within the Bureau of Biological Survey are the potential agencies for promoting a national movement for wildlife restoration. The knowledge and approved methods for such public activities must be provided and services extended to all State educational institutions and conservation organizations in position to cooperate. This report presents the accomplishment in these directions during the past year.

To bring about a more complete coordination between the functions and the objectives of the Bureau, arrangements were completed at the close of the year for changes in organization, effective July 1, 1934. These involve the consolidation of the former Divisions of Game and Bird Conservation and of Predatory Animal and Rodent Control into a new Division of Game Management; the creation of a Division of Public Relations, by consolidating two sections formerly responsible directly to the chief, and the assignment to it of additional functions in special correspondence and in relations with States; the creation of a new Division of Migratory Waterfowl; and the extension of the functions of the Division of Administration.[2]

BUREAU PERSONNEL

The officials directing the major operations of the Bureau are as follows:

Associate Chief	
Technical Advisor	W. C. Henderson
Division of Administration	W. L. McAtee
Division of Public Relations	W. R. Dillon
Division of Wildlife Research [2]	H. P. Sheldon
Section of Distribution and Migration of Birds	W. B. Bell
Section of Food Habits Research	F. C. Lincoln
Section of Fur Resources	Clarence Cottam
Section of Disease Control	F. G. Ashbrook
Division of Migratory Waterfowl	J. E. Shillinger
Division of Land Acquisition	J. C. Salyer
Division of Game Management	Rudolph Dieffenbach
Section of Reservations and Game Agents	Stanley P. Young
Section of Law Enforcement	W. E. Crouch
Section of Importations and Permits	F. P. Callaghan
Section of Predator and Rodent Control	R. W. Williams
	A. M. Day

[1] This report covers parts of two administrations of the Bureau of Biological Survey: On Mar. 1, 1934, Paul G. Redington, who had directed the work since May 9, 1927, was transferred at his own request to the Forest Service, to resume administrative work in an organization with which he had had 23 years' previous service. The present chief was appointed on Mar. 10 and assumed office on Mar. 19, 1934.

[2] By additional reorganization effective Sept. 22, 1934, the former research divisions were consolidated as sections of one Division of Wildlife Research.

For efficient administration the field work of the Division of Game Management will be directed through eight regions, as follows:

(1) Pacific region (headquarters), Portland, Oreg.; (2) Mountain-Plains region, Denver, Colo.; (3) Southwestern region, Phoenix, Ariz.; (4) West Central region, Winona, Minn.; (5) Southern region, Starkville, Miss.; (6) East Central region, La Fayette, Ind.; (7) South Atlantic region, Washington, D. C.; and (8) Northeastern region, Amherst, Mass.

DEATH OF FORMER CHIEF

It is fitting here to record the death on May 19, 1934, in his eightieth year, of Edward William Nelson, third chief of the Biological Survey, from December 1, 1916, to May 8, 1927, and a member of the Bureau from 1890 to the time of his retirement at the age of 74 in 1929. His administration saw the expansion of the Bureau's work on bird conservation through administration of the Migratory Bird Treaty Act, its studies of the habits and distribution of birds through the bird-banding method, and the development of cooperative work with the States in predator and rodent control, including the building up of a trained field organization. Dr. Nelson originated the movement that resulted in the passage of the Migratory Bird Conservation Act, which became law just before his retirement from the Bureau, and in the passage this year of the Migratory Bird Hunting Stamp Act. He was instrumental also in bringing about the negotiation of the treaty of 1916 with Great Britain for the protection of birds that migrate to and from Canada, and the enactment of the Alaska Game Law of 1925, which established the present Alaska Game Commission, and in inaugurating the Bureau's work for the improvement of the reindeer herds in Alaska. His broad interests in wildlife conservation and his indomitable courage in the face of physical handicaps have been an inspiration not only to his associates in the Government but also to hosts of officials and members of scientific and conservation organizations.

RETIREMENTS OF VETERAN SCIENTISTS

On July 31, 1933, two veteran scientists and authors of the Biological Survey were retired—Vernon Bailey, after 46 years' service; and Theodore Sherman Palmer, after 44 years'. Mr. Bailey's work was chiefly in mammalogy and in conducting biological surveys of major areas; Dr. Palmer's included research, game-law enforcement, and administration; for many years between 1896 and 1914 he served as assistant chief of the Bureau and part of this time as acting chief, having prepared and transmitted the annual reports for the 4 years 1898–1901.

WILDLIFE REFUGE FUNDS

In January the Secretary of Agriculture appointed the members of the President's Committee on Wild-Life Restoration, whose report, signed by its chairman, Thomas H. Beck, recommended the allocation of $25,000,000 for the restoration of submarginal and other lands suitable for development for game, nongame, fur, and other species. The other two members of the committee were Aldo Leopold and the present Chief of the Biological Survey. The funds since made available to the Bureau total $8,500,000, in addition to its regular annual appropriation.

In carrying on its refuge program, the Biological Survey has received valuable cooperation from the Public Works Administration, the Emergency Conservation Work organization, the Federal Emergency Relief Administration, and other agencies, and in turn the Bureau has given every possible assistance to the Government's recovery program.

Of the emergency allotments now available, $1,000,000 is from E. C. W. funds, set aside by Executive order for the acquisition of migratory waterfowl refuges; $1,500,000 is from funds allocated for the withdrawal of submarginal lands, to be devoted to the production of migratory waterfowl; $3,500,000 is in drought-relief funds, to be used to purchase lands suitable for wildlife sanctuaries within drought-stricken regions; and $2,500,000 is in P. W. A. funds, for engineering operations to restore and control water levels, to stop soil erosion, and to improve food and other environmental conditions on Federal wildlife refuges. Additional funds to the extent of $600,000 to $1,000,000 are

in sight for refuges, though the operation of the Migratory Bird Hunting Stamp Act of March 16, 1934, which provides for the issuance of stamps through post offices at $1 each, to be in the possession of every person over 16 years of age who engages in the pursuit of ducks and geese, and for the expenditure by the Biological Survey of 90 percent of the revenue for the purposes of the act, the remaining 10 percent to cover administrative expenses, the printing and distribution of the stamps, and the protection of the birds.

LAND-UTILIZATION PROGRAM AND WILDLIFE

The rapid decrease of wildlife during the past half century has been hastened by the unwise appropriation of millions of acres that originally produced an abundance of game, fur bearers, and fish. Restoring these tracts is a principal objective of the national land-utilization program. This will afford a long-awaited opportunity to increase valuable forms of American wildlife through the establishment and maintenance of an extensive system of refuges. With the emergency funds available at the end of the year, surveys were completed or are under way, and acquisitions were begun on suitable tracts along the principal flight lanes and habitats of migratory wild fowl. Among areas acquired at the end of the fiscal year, or in process of acquisition, were the following:

Area:	*Approximate acreage*
Lake Mattamuskeet, N. C	50,000
Beltsville, Md	800
Mud Lake, Minn	50,000
Union Slough, Iowa	5,000
Wingo Swamp, Mo	15,000
White River, Ark	49,000
Des Lacs, N. Dak	75,000
Mouse River, N. Dak	80,000
James River, N. Dak	70,000
Lake Andes, S. Dak	16,000
Medicine Lake, Mont	15,000
Turnbull Slough, Wash	5,000
Lake Malheur, Oreg	80,000
The Spalding Ranch, Calif	15,000
Upper Mississippi River Wild-life and Fish Refuge	1,000

The conditions most favorable to wildlife are identical with those that reduce erosion and promote flood control and soil restoration by the conservation of water resources and the production of luxuriant growths of vegetation for food and cover. The development of the refuge system will include replanting of food plants, raising water levels by the construction of small dams and dikes, reflooding drained areas, and impounding water in the upper tributaries of waterways.

OUTSTANDING EVENTS OF THE YEAR

The following is a brief summary of the outstanding events of the year in the work of the Bureau, or having an effect upon it. Many of them are discussed in some detail under the appropriate sections of this report on wildlife research, utilization, protection, or control.

Announcement of the reorganization of the work of the Bureau, with changes in administrative personnel and the creation of new divisions, effective July 1, 1934.

Passage of legislation by the Seventy-third Congress authorizing the establishment of fish and game sanctuaries on national forests (Pub. No. 120, Mar. 10); providing for coordination of interdepartmental work to insure that engineering projects that might adversely affect wildlife resources are instituted only after advice has been sought from the Bureau of Biological Survey or the Bureau of Fisheries (Pub. No. 121, Mar. 10); and requiring that a $1 migratory-bird hunting stamp be affixed to licenses of waterfowl hunters (Pub. No. 124, Mar. 16).

Creation of a Special Committee on Wild-Life Conservation in the House of Representatives.

Appointment of the President's Committee on Wild-Life Restoration and the publication of its recommendations.

Completion of a most exhaustive study of the waterfowl situation throughout the United States and on important Canadian breeding grounds, including an analysis of the abundance, movements, and food resources of the birds, and the collection of data on baiting and other hunting practices, as a basis for hunting regulations.

Observations of the work of Civilian Conservation Corps camps on eastern national forests, with recommendations for the conservation of food and cover plants for wildlife without detriment to the forest-improvement operations.

Investigations of conditions affecting the Roosevelt elk of the Olympic Peninsula, Wash., with recommendations to officials of the Forest Service and the State regarding herd management.

The birth of 7 calves (5 still living) in the herd of musk oxen reestablished by the Bureau in Alaska in 1930, the first births of the species in the Territory for more than a century.

Satisfactory outcome of research in California for developing selective control methods of birds injurious to agriculture and horticulture.

Announcement to fox farmers by the Farm Credit Administration that silver foxes are eligible security for loans to aid the industry, following consideration of data presented by the Biological Survey, gathered in cooperation with fox breeders and their associations.

Beginnings of expenditure of extensive allotments for emergency funds for the acquisition, development, and improvement of refuges for migratory birds.

A successful experiment in concentrating on short notice a mobile force of law-enforcement agents in an area where violations of the Migratory Bird Treaty Act were particularly flagrant, resulting in the arrest of 78 poachers and in putting an effective stop to violations.

Definite control of typhus fever in Georgia, Alabama, and Texas through the destruction of at least 7,500,000 rats in a campaign conducted for the purpose under a Civil Works Administration project in cooperation with the United States Public Health Service.

Prosecution of rodent control on nearly 5,000,000 acres of Indian-reservation and national-forest infested lands, through the employment of Civilian Conservation Corps workers.

RESEARCH ON THE STATUS AND RELATIONSHIPS OF WILDLIFE

COMPREHENSIVE STUDY OF WATERFOWL

The continuance of unfavorable waterfowl conditions led the Biological Survey to increase its efforts to collect information and make the facts public. Resulting from extended investigations, continued from previous years, but amplified and intensified, the data gathered constituted the most exhaustive report on the current conditions of migratory waterfowl ever compiled. Maps were prepared from data collected in the field to show the principal breeding ranges and the regions of sport shooting of 24 of the most highly prized species of waterfowl and to portray the parts of the normal breeding ranges that had been rendered practically unproductive by shortage of water, food, and cover. These maps, accompanied by explanatory data, have been prepared for distribution as a printed document. (Misc. Pub. No. 210.)

This year's drought is the culmination of reduced rainfall prevailing since 1915 over a large part of the waterfowl-breeding grounds of the Northwestern States and the southern parts of the Prairie Provinces of Canada. Reports by the United States Weather Bureau and the Meteorological Service of the Dominion of Canada indicate that it is the longest continued, covers the greatest area, and is the most severe in the known history of the two countries. Combined with encroachments on breeding grounds by agriculture and drainage operations, and shooting by increased numbers of well-equipped hunters provided with transportation facilities that enable them to reach quickly the favorite hunting grounds, it has caused alarming losses of waterfowl.

A close check was kept by representatives of the Bureau in Canada and the United States, and by a large number of cooperative observers, on the outcome of the breeding seasons of 1933 and 1934, and a special study was made during the open season of 1933 of baiting, a practice that has accentuated the seriousness of the waterfowl problem. Experienced representatives of the Survey were sent to the more important nesting regions during the breeding season, and intensive investigations will be continued next fall and winter.

The results of all these investigations have shown conclusively an appalling shortage of waterfowl, a particularly serious plight of certain important species, and the necessity for taking immediate steps to save an adequate breeding stock. These reports have been widely commented upon by the daily press and outdoor periodicals, and have provided a basis of scientific fact for waterfowl-hunting regulations.

BANDING GAME AND OTHER BIRDS

Study of migratory and other birds by the banding method continues to demonstrate its value in obtaining authentic information and its popularity among both sportsmen and nature students. Banding stations are now operated at various points throughout the United States and Canada by 1,874 cooperators. These stations, selected with care, cover as adequately as is now possible the important migration routes of the various species. Technical workers are cooperating in increasing numbers, and State universities, agricultural colleges, and other scientific and educational institutions are actively engaging in this means of research.

Birds reported as banded during the year totaled about 364,000, an increase of more than 100,000 over last year. Banded birds recovered at various points numbered more than 18,000, an increase of nearly 2,000. The critical waterfowl situation, and the necessity for obtaining reliable information regarding flight routes between breeding and wintering grounds, stimulated special work at waterfowl-banding stations, at 50 of which 40,534 ducks and geese of 26 species were banded. These represented all the important game species and registered an increase of about 25 percent over last year. For the first time the mallard dropped to second place among the birds banded, the number being 9,424, as against 14,290 pintails, probably the result of several stations having deliberately concentrated on the latter. Return records for banded ducks and geese totaled 5,775.

A report, based partly on bird-banding studies, was published under the title "Restocking of Marshes with Hand-reared Mallards not Proved Practicable" in the Yearbook of Agriculture, 1934 (pp. 310–313).

RESEARCH ON BIG-GAME MAMMALS

OLYMPIC AND OTHER ELK

At the request of the Forest Service, and with the active cooperation of the State Game Commission of Washington, a study was made of the Roosevelt elk, of conditions affecting these animals on the Olympic Peninsula, and of the elk herds on the Snoqualmie National Forest. On the Olympic Peninsula a close season on the elk had been maintained for many years, up to the fall of 1933, when a short open season was allowed, State officials being of the opinion that some hunting would be beneficial in areas of overpopulation. The diversity of opinion regarding this action made it desirable to study the numbers of the elk in various localities on the peninsula, their distribution in relation to the available food supply, and the economic and ecological effects of their grazing and browsing. A representative of the Biological Survey who has had extended experience in studying elk problems made the investigations, and his report indicated the desirability of a short open season during the fall of 1934, with proper limitations as to the number of elk to be taken in the various localities, and careful supervision of hunting. His recommendations were submitted to the State game officials for their use in fixing the hunting season and prescribing hunting and management practices. On the Snoqualmie National Forest attention was given to the numbers of elk present and their relationship to the Rattlesnake Game Preserve. Sound and silent motion pictures were prepared, depicting the life history and habits of the elk of the Jackson Hole region.

MOUNTAIN-SHEEP CROSS-BREEDING EXPERIMENTS

The results were observed of crossbreeding experiments between the Dall mountain sheep and domestic sheep of Merino strain, conducted in cooperation with the Alaska College of Agriculture and School of Mines. The herd consists of 1 mountain-sheep ram, 6 domestic ewes, 3 crossbred yearlings, and 4 crossbred lambs born during the spring of 1934. The coat of the crossbred animals is largely composed of wool, with an admixture of hair, and the animals have larger frames than either the mountain sheep or the domestic sheep. In the course of summer grazing it was observed that the mountain sheep and the crossbred animals were not bothered by gnats and mosquitoes. The domestic sheep were troubled by attacks about the eyes, which often result in blindness. The crossbred animals appear to be hardy and well adapted to conditions in Alaska, and to indicate the definite value of developing a type of sheep

suited to production under the rigorous conditions there. Breeding was prevented until the middle of November, so that the lambs would be dropped in April and May, the gestation period being approximately 150 days.

RESEARCH ON FOREST WILDLIFE

Good progress was made during the year in studying the relationships of wildlife to forestry, grazing, and other land use, and recommendations and plans were prepared relating to management practices.

INFLUENCE OF MICE ON FOREST REPRODUCTION

Investigations in the southern Appalachian region were made of the relationship of logging practices and slash disposal to the rodent population, and their effect on the reseeding of these areas to valuable timber types. An abnormal increase in the number of mice was due in part to the protection that slash afforded them from their natural enemies and to the availability of food in the presence of slash on the ground. Under such circumstances natural forest reproduction was found to be greatly reduced or totally lacking.

Investigation of damage to nursery stock on the Bent Creek Experimental Forest, near Asheville, N. C., revealed the presence of the harvest mouse for the first time. Smallest of the native mice of the region and normally considered harmless, it here proved surprisingly destructive to a bed of mountain pines, from each of which it had completely stripped the outer bark and cambium from the ground to the top.

Not until this year has any damage been noted from pine mice in this mountainous region, but late in winter one check area was found where all the pine seedlings had been killed by their roots being eaten off. Though the pine mice, when present in large numbers, are a potential menace to nurseries and gardens, they will probably not prove a serious problem on timberland except under radically modified conditions.

In the Southwestern States studies were made of the relationship of deer mice and meadow mice to stands of Douglas fir. In a heavily cut-over area twice as many deer mice and 23 times as many meadow mice were taken as in a nearby stand of Douglas fir. The rodents were much less abundant in thick stands of aspen, ponderosa pine, and oak than in open cut-over areas.

ROLE OF PREDATORS IN SUPPRESSING FOREST RODENTS

On the Bent Creek Experimental Forest a study of the fall and winter feeding habits of the gray fox shows rather conclusively that it lives almost entirely on mice, rabbits, and such fleshy fruits as persimmons and wild grapes. In only a few cases were bird remains found. The growing scarcity of birds of prey may make the gray fox increasingly important in rodent control. Studies of the relationship to predators of game-bird populations also have been continued.

BEAVER AND DEER TRANSPLANTINGS

Beavers have continued to increase where planted on forest lands in the vicinity of Asheville, N. C., where during the winter it was estimated that there were approximately 20 of these valuable fur bearers on one small lake. As there is an insufficient food supply available to support this number very long, plans were made for transplanting some to establish colonies on State and Federal game refuges in the southern Appalachian Mountains. Early in January, four were trapped and liberated on a lake in the Cherokee National Forest, near Blairsville, Ga., where they have adapted themselves satisfactorily to their new environment.

Deer studies on forests have been largely concerned with a survey of overabundance and means of reducing the surplus by trapping and distribution to other refuges. Through local cooperation, traps were constructed into which deer were successfully driven and crated for shipment with relatively little injury or loss. Over a period of several months during late winter, approximately 200 were thus captured in North Carolina forests and distributed to forested areas elsewhere.

A study was also made of conditions in the San Francisco Mountain Game Preserve, Arizona, where deer were found to be moderately abundant. Although

they do not yet threaten damage to ponderosa pine or other of their natural food plants, a system of rotating deer refuges seems desirable for northern Arizona.

SNOWSHOE RABBITS AND REFORESTATION

In a study of snowshoe rabbits and their relationship to forest reproduction on cut-over lands in the Lakes States region it was found that rabbits periodically damage plantations through their destruction of pine and spruce seedlings, by eating off the terminal and lateral branches. When the rabbit population is at a low ebb, however, little damage is noticeable. Most of it is in or near areas of dense low cover. Control by altering present silvicultural practices or reducing the numbers of rabbits is desirable only during the peak periods of rabbit abundance and then only on and adjacent to plantations planted or ready for planting.

Attention in the Lakes States region also has been given to planning wildlife management practices adapted to forestry conditions. This includes the taking of game censuses, introducing game animals where advisable, planting suitable game foods, and supervised removal of predators and other animals injurious to the forest trees and to valuable animal life.

STUDIES OF OTHER FOREST WILDLIFE

Field studies of the life history of wood rats in Arizona were virtually completed during the year, and additional work was done on the relationship of jack rabbits to the stand of grass and other grazing plants. A detailed study was also made of the abundance of rodents covering a strip 20 to 30 feet wide and 56 miles long on the Santa Rita Range Reserve, Ariz., to provide a better understanding of rodent distribution especially as related to vegetation and soils. Two small field laboratories were constructed with P. W. A. funds. Through cooperation with the University of Arizona, assistance was rendered in upland game studies; and through cooperation with the Soil Erosion Service of the Department of the Interior the relationship of rodents to livestock grazing and soil erosion on the Navajo and Hopi Indian Reservations was studied. Assistance also was given on submarginal land problems in cooperation with a committee on wildlife relationships of the University of Arizona, and maps were prepared indicating areas that might be suitable for wildlife development. Similar studies also were made on the public domain and on private lands adjacent to national forests and Indian reservations.

INFLUENCE OF C. C. C. ACTIVITIES ON WILDLIFE

At the request of the Forest Service a biologist made a detailed inspection of the cultural work of the Civilian Conservation Corps camps on national forests in the southern Appalachian Mountain region, from northern Virginia south into Alabama. He visited camps on each forest, and studied the work from the viewpoint of its effect on wildlife. Recommendations were made to the Forest Service on means by which the operations might be improved in the interest of wildlife without detriment to the forest-improvement work. Similar work also was done in the Allegheny National Forest in Pennsylvania. In the Yearbook of Agriculture, 1934, an article was published (pp. 373–376) on Wild Life Factors Important in Efforts to Improve Forests.

IMPROVEMENT OF REINDEER INDUSTRY IN ALASKA

The substation at Nome of the reindeer experiment station was closed early in the year because of reduced appropriations, and it was not possible to undertake further field studies of reindeer-caribou crossbreeding experiments on Nunivak Island. About 75 caribou, including 5 particularly large bulls and about 25 fawns, were trapped last spring in one of the fenced pastures during an unprecedented migration through the immediate section about the reindeer experiment station at College, to be used in crossbreeding experiments with reindeer.

MUSK-OX INVESTIGATIONS

The most notable event in the herd of musk oxen since their introduction into Alaska in 1930 was the first calving of the animals at the reindeer experiment station. Two calves were born on April 29; 2 on May 1 (1 weighing 24½

pounds being still-born); the fifth on May 10, the sixth on June 8, and the seventh on or about June 24. The calves were subject to attack by the older animals, particularly the bulls, and the last calf born, weighing 17 pounds, died of injuries thus received. Of the 9 cows, now 5 years old, 7 gave birth to calves. There are in addition 4 cows now 4 years old that did not breed.

Effective patrol to protect the musk oxen from predatory animals proved particularly difficult owing to the dense brushy thickets on the pasture. Eight black bears and one black wolf were killed, and during the spring several men were employed in clearing out brush about the enclosure to facilitate patrol.

During the shedding period 24 pounds of musk-ox wool was collected and turned over to the extension service of the College of Agriculture and School of Mines for weaving experiments, and many scarfs that sold at $10 each were woven by girl students. Further experiments are being conducted in weaving such articles as mittens, socks, and baby clothes. Previous studies by textile experts have shown that the wool compares favorably with cashmere and vicuna, and holds considerable promise for successful development in the making of garments that are exceptionally light, soft, and warm.

Of the 34 musk oxen introduced 4 years ago, 24 survive. There are now 13 cows of breeding age in the herd, 11 bulls, and the 5 calves, and steady increase is anticipated.

SCIENTIFIC REFERENCE COLLECTIONS AND RECORDS

Consistent progress was made in assembling and recording scientific information based on collections of specimens and data obtained regarding the life history, habits, and distribution of mammals and birds. Many investigators, including a number from foreign countries, utilize the laboratories and the record files at Washington. During the fiscal year 489 mammal specimens were identified for 41 institutions and individuals in 18 States; loans of 170 specimens were made to 9 institutions and individuals in 7 States and 1 foreign country; and 627 mammal specimens were borrowed for use of specialists from 9 institutions in 6 States and 1 foreign country. The number of mammal specimens received for permanent deposit in the Biological Survey collection was 636, nearly twice the number received last year.

Activity in describing new forms of mammals has been particularly pronounced during the year. In articles published in various journals by the staff of the Biological Survey, 64 were described as new. New type specimens of mammals added to the Biological Survey collection numbered 53, belonging to the following genera: *Felis*, 2; *Thomomys*, 24; *Cratogeomys*, 15; *Orthogeomys*, 1; *Perognathus*, 2; *Dipodomys*, 5; *Sigmodon*, 2; and *Neotoma*, 2. The number of type specimens of mammals now in the Biological Survey collection is 907. A total of 4,400 mammal records were added to the card information files.

During the year 1,632 bird specimens were added to the collection, chiefly from North Carolina and Georgia. The number of new card records for the year totals 27,615, making the grand total more than 1,954,000 card records on the distribution and migration of birds, exclusive of data in the bird-banding files. These carded records include invaluable data gathered over a period of nearly half a century, and are made readily available in this form for the use of scientific investigators throughout the country as well as members of the Survey staff. Assistance given other scientific and administrative organizations included identifications of 734 birds for museums, educational institutions, and other organizations; assistance also was given cooperators engaged in preparing publications on the birds of the following States: Louisiana, Iowa, Missouri, Indiana, Virginia, Washington, Utah, North Carolina, Oregon, and Nevada; and 403 birds were loaned to specialists making studies of particular groups or regions. Much work has also been done in keeping the taxonomic classification of the collection of specimens up to date, and in conformity with revisions of the various groups.

A comprehensive article on the research work of the Biological Survey and a historical account of the Bureau's work was prepared under the direction of the Chief, and published with illustrations in the October 1933 issue of the Scientific Monthly; and a short chapter on the same subject was published in a general account of the history and functions of the Department, in Miscellaneous Publication No. 88, revised.

During the year a report on Cave Life in Kentucky, prepared in the Biological Survey in cooperation with the Kentucky State Geological Survey, was pub-

lished by the University Press, Notre Dame, Ind., reprinted from the American Midland Naturalist, to which the Bureau submitted it for publication in May 1933.

ECONOMIC STUDIES OF WILDLIFE

WILD-FOWL FOOD RESOURCES

The shortage of eelgrass on the Atlantic seaboard and the consequent abrupt decrease in numbers of eastern-coast sea brant have engaged the attention of the Biological Survey for several years. While in some places the eelgrass is in a more serious condition than last year, it seems to show noticeable improvement in a number of sections and a slight improvement over the major part of its range in the United States. Some areas, however, that formerly supported a dense growth of the plant are now almost completely denuded. In general, the best improvement is noted in areas of reduced salinity. The less technical aspects of this 3-year study are presented in an article in the Yearbook of Agriculture, 1934 (pp. 191–193), Eelgrass Disappearance Has Serious Effects on Waterfowl and Industry.

Starvation of waterfowl on the Atlantic coast was the subject of an investigation during February. Because of an unusually severe and extended period of cold and heavy freezes, it became necessary, in cooperation with State officials, to undertake extensive feeding of waterfowl on Chesapeake Bay and the Potomac River in Maryland and Virginia. Feeding also was done in other sections of the Northeastern States.

Waterfowl food-resource surveys were made of most of the lakes in northwestern Iowa, in coastal regions of Texas, and in parts of Oregon and Washington. Experimental waterfowl-food plantings also were made in some of the fresh-water lakes and streams of the two States last named. The effect of drought upon waterfowl-food conditions was studied in Minnesota, Iowa, Illinois, North Dakota, South Dakota, and Montana. It was urgently recommended that water be impounded where possible.

Proposed bird-refuge areas in Virginia, North Carolina, South Carolina, New Mexico, Arizona, and Oregon were surveyed as to biological suitability for acquisition. Investigations and recommendations were made for the improvement of wild-fowl food resources on various Federal bird refuges in Maryland, North Carolina, Florida, Nebraska, Utah, and California, and similar cooperative investigations were made of lakes on State refuges in Virginia and North Carolina.

A survey was made of the present wildlife population, food resources, and probable effects of the creation of a proposed fresh-water lake of that part of Great Salt Lake, Utah, east of Antelope Island. The project was not recommended because of the inadequate and unstable water supply and the apparent probability that a serious outbreak of botulism, or western duck sickness, might result.

Field studies were made of the relation of mosquito-control operations to waterfowl food plants in a number of marsh areas of the East. It is apparent that serious injury is being done to wildlife through mosquito-control work.

A survey of waterfowl conditions and of baiting and other gunning practices undertaken at the request of the advisory board, Migratory Bird Treaty Act, occupied the attention of Bureau specialists for periods varying from 1 to 3 months. Practically every important gunning section was investigated. Notes on the abundance, distribution, and availability of waterfowl-food plants during the fall and winter were made and many data obtained on the present status of ducks and geese from the viewpoint of distribution, number, sex ratio, proportion of young to adults, and gunning practices. The report of this study, which was summarized for the board in a 17-page mimeographed circular, concluded that baiting as now practiced is not a conservation measure, but is employed in order to increase the kill of waterfowl. Most species have shown a noticeable decrease during the past 5 years.

FIELD INVESTIGATIONS OF INJURIOUS BIRDS

Studies in control methods and research on crop depredations by birds in California were continued, and special assistance was furnished by the State department of agriculture and county agricultural commissioners in coping with attacks by horned larks on beans and other vegetable crops, crows on sugar

beets and almonds, and linnets on figs and other fruit crops. In the case of blackbird damage to rice, cooperation was received not only from county officials as noted above but also from rice growers' associations. The policy of the Bureau in this type of work, the need for which recurs annually, and a summary of the effects of the control methods recommended, are embodied in an article prepared for the Yearbook of Agriculture, 1934, and published under the title "Bird Species Not Menaced by Local Control Campaigns" (pp. 149–152).

Depredations on crops by migratory wild fowl are found to be serious in certain localities. Investigations were made in Colorado, Nebraska, Oklahoma, Texas, New Mexico, California, Washington, and Oregon. Most of the damage was done to grain, though young hay crops were seriously injured in a few localities in Washington and Oregon. In Texas and New Mexico the sandhill crane, rather than waterfowl, appeared to be the chief offender.

An investigation was begun to determine the biological relationship between predators, rodents, and quail on a Virginia game farm, and an annoying diurnal roosting of turkey vultures in the vicinity of Washington, D. C., was investigated and recommendation made for its removal.

During May and June field investigations of crows in relation to nesting waterfowl were conducted in the Canadian prairie section, in the North Central States, and in Colorado. The most extensive of these concerned a single lake in the Canadian breeding area of Saskatchewan, where the damage by crows was found to be serious. Further investigations are planned, to learn the destructiveness under average conditions. Only slight damage by crows was discovered in the North Central States, and practically none by either crows or magpies was noted in the Colorado area. Because of the severity of the drought, however, the two areas last named supported few ducks or crows, so that the findings there were probably not representative of normal years.

An investigation of the Upper Mississippi River Wildlife and Fish Refuge and the Lake Erie marshes of Ohio showed that skunks, crows, and brown rats were somewhat destructive to nesting waterfowl.

LABORATORY WORK IN FOOD HABITS OF WILDLIFE

A large part of the laboratory study of food habits of wildlife was carried on for States, institutions, or individuals. Workers in the Washington office examined 853 bird stomachs, 979 hawk and owl pellets, 10 lots of miscellaneous bird-food items, 517 mammal stomachs, and the feces of 1 amphibian and 3 reptiles. In the food habits research laboratory at Denver, Colo., the stomachs of 2,816 mammals were examined—2,735 coyotes, 37 bobcats, 23 bears, 15 armadillos, 3 mountain lions, 2 raccoons, and 1 fox.

The project on the food habits and economic relationships of the fish-eating birds has been materially advanced; the stomachs of 77 ruffed grouse were examined; and a technical bulletin on the crested myna was prepared for publication. A report on some early summer food preferences of the American raven in southeastern Oregon was published in an ornithological journal.

In cooperation with the southwestern quail investigation, analyses were made of the stomach contents of 55 Gambel's quail. For the cooperative project on the bobwhite in Wisconsin, 591 pellets of the great horned owl were examined. For the New England grouse investigation, the stomachs of 218 ruffed grouse and a series of raptors were studied, and the findings were published in a mimeographed leaflet (Bi–1297), Winter Food of the Ruffed Grouse in the Northeast. Mammal-stomach examinations to the number of 421 were made for Bureau investigators, 37 additional fox stomachs were studied in the cooperative project with the Virginia Commission of Game and Inland Fisheries, and a study of the food habits of Connecticut fur bearers was initiated in cooperation with the State superintendent of fish and game. Many special examinations also were made for universities, other institutions, and individuals.

All stomachs of diving ducks in the Survey collection have been examined, thus completing the laboratory work for a final report on the food habits of these birds.

A report prepared for the American Society of Mammalogists, entitled "Autumn Food Habits of Coyotes, A Report of Progress, 1932", was published in that society's journal in August, and was followed by a paper read at the society's annual meeting on the Winter Food Habits of Coyotes, A Report of Progress, 1933. These present a summary of the findings thus far obtained.

There were accessioned during the year 4,807 mammal stomachs, chiefly predators, and additions were made to the reference collections as convenience

permitted or necessity required. Duplicate sets of part of the mammalian-hair slide collection were prepared, one for deposit in the Washington laboratory, and a series of drawings of mammalian hairs is being made for reference.

As part of an economic study made in connection with waterfowl investigations and white-necked raven depredations, 572 bird stomachs were analyzed in the Denver laboratory, and specimens of seeds and plants were collected and identified in the field work on waterfowl food and cover plants.

The reference collections, so essential in all branches of food-habits investigations, were improved and added to during the year. The seed collection now contains 6,616 specimens of 4,553 species, representing 1,345 genera of plants most frequently taken as bird food. Additional drawings were prepared for a projected manual on wild-fowl foods, and many additions were made to the photographic file of native cold-blooded vertebrates, available for educational purposes and for use in connection with proposed food-habits studies.

The most tangible results of laboratory work on food habits, as always, are publications revised or newly issued. Two manifold leaflets for use in answering correspondence, Publications on Cage Birds (Bi–173) and Dealers in Cage Birds and Cage-Bird Supplies (Bi–631), have been revised; and two more, Planting for Wildlife in the Corn Belt (Bi–1326) and Planting for Wildlife in the Cotton Belt (Bi–1327), were issued. The two last mentioned, together with Farmers' Bulletin No. 1719, Improving the Farm Environment for Wild Life, are of special value both to farmers who have agreed to withdraw land from growing competitive cash crops and to those living on land that is more or less submarginal. Winter Feeding of Wild Life on Northern Farms, issued in the Miscellaneous Publication series (no. 159), is a comprehensive treatment of the problem of providing wild birds and mammals, especially game species, with an adequate and reliable supply of food. A leaflet (96–L), much needed to facilitate answering correspondence, Protecting Poultry from Predacious Birds, was published during the year.

FIELD STUDIES OF THE FOOD OF MAMMALS

In continuing detailed studies of the food and other habits of the Texas armadillo, investigations were conducted in the field, and careful laboratory examinations are being made of the stomachs collected. Laboratory feeding experiments have also been combined with field experimentation to determine the relation of the armadillo to nesting quail and their eggs. The investigation shows that the armadillo is largely insectivorous and only in a slight degree or under unusual circumstances seriously detrimental to agriculture. Some field work was also done by one investigator on the food habits of predatory mammals. In the Pacific Coast States further studies were made of pocket gophers and other rodents.

RESEARCH ON FOOD HABITS OF FOREST WILDLIFE

A report on an investigation of the relation of vertebrate animals to the white pine weevil in New England has been prepared for publication, completing the work on this forest-fauna project. Studies in New England on the relation of forest wildlife to forest management were continued. Forest-game management studies are being made in New Hampshire from headquarters in the Pillsbury State Forest. Wildlife and other biological investigations were made also in the Bartlett Experiment Forest, in New Hampshire; and in the Chenango Experimental Forest, in New York.

UPLAND-GAME STUDIES

At the request of the Soil Erosion Service, surveys and recommendations were made for improving the environment for wildlife on areas in Wisconsin and New Mexico. On the New Mexico area (the Navajo Indian Reservation) it was found that excessive grazing was very destructive to the wildlife of the area. Investigations and recommendations also were made at C. C. C. camps in Maryland regarding upland-game-bird areas.

Of the series of experimental upland-game-bird management projects in which the Survey has cooperated, the Arnett project in Oklahoma has been canceled by the State game and fish department. Because of the unusual importance of this particular area, however, in the opportunity it affords for

prairie-chicken studies, cooperative funds have been provided to continue the work, and the Survey will continue to serve as a cooperator. Six other cooperative projects—2 in Arkansas, and 1 each in Oklahoma, Indiana, North Carolina, and South Carolina—are being continued, and much valuable information is thus being obtained on game management.

RESEARCH IN FUR PRODUCTION

IMPORTANCE OF FUR AS A NATURAL RESOURCE

With few exceptions the States reporting show a decided decrease in the 1933 catch as compared with that of 1932, even though the prices paid for raw furs had increased slightly at the close of the 1932 season. When the fur trade regains its normal condition it will probably face so marked a shortage of American raw furs that the increased prices will send every country boy to the village for more and more traps. The natural result may be a period not of scarcity of furs but of actual lack. The Biological Survey has continued to cooperate with State game commissions, raw-fur dealers' associations, and others in keeping before the public the necessity of obtaining records of the annual catch in the various States. Unfortunately few fur laws require such reports, and not until all States have legislated on the subject can estimates be made of the catch throughout the country.

The conservation of fur resources is of exceptional importance to the United States, not only because of the potential financial returns to trappers but also because of the employment of people in the fur business. At his request the Bureau sent to the Chairman of the Special Committee of the House of Representatives on Conservation of Wild Life Resources a detailed report on the importance of conserving fur as a natural resource. Through the cooperation of agencies interested in wildlife conservation, the Bureau hopes to be instrumental in restoring at least part of this wasted heritage.

Since a considerable part of the original range of fur animals is now under cultivation, it would be both unwise and impossible to restore all the species to all their former haunts. Crop and livestock production has contributed extensively to decreasing the natural supply of fur animals. These could be introduced into extensive areas unprofitable for agriculture, however, for their presence not only would enrich the forests and parks with interesting species but economically would add to the decreasing supply of valuable fur. Intelligently managed, a project for restocking beavers, for instance, has tremendous possibilities for increased fur production.

To pursue the restoration of beavers and other fur animals successfully it is necessary to establish definite and practical policies of management. To this end the Bureau of Biological Survey is effecting a closer cooperation with the Forest Service, the National Park Service, and State game commissions. The Bureau has continued the compilation of such data as are available on the numbers of fur animals taken in the various States; it has projected investigations to increase our knowledge of the present status of the more important species; and during the year it issued a mimeographed abstract of State laws on trapping seasons.

FOX FARMERS AIDED BY FARM CREDIT DECISION

The announcement by the Farm Credit Administration that silver foxes are eligible security for loans, even though it came rather late in the season, was encouraging news to fox farmers, many of whom had faced difficulty in carrying their animals through the winter and in financing the production of the next season's crop of pelts. This action was in part based on data prepared by the Bureau in cooperation with breeders and associations representing the silver-fox industry. It has been effective in placing fur farming in a more stable position in the general agricultural field.

In times of stress persons engaged in agriculture and related industries especially need guidance and cooperation from the Federal Government. The demands for information on fur production have thus been unusually great during the past 3 years, and as much as possible has been accomplished with the limited personnel and funds available.

FUR ANIMAL EXPERIMENT STATION INVESTIGATIONS

PRODUCTION-COST STUDIES

Improved types of pens, dens, and feeding equipment have been investigated at the fur animal experiment station at Saratoga Springs, N. Y., in order to obtain information as to the extent of overhead charges and as to measures of economy in labor and feed costs. Accurate records are kept of food consumption and feeding costs for foxes, fishers, martens, minks, and raccoons.

Experiments to determine more economical and efficient methods of feeding foxes were continued. Two years' study of the value of dehydrated beef meal as a cheaper substitute for 75 percent of the raw meat in the ration has been completed. No appreciable difference was evident in the health, breeding performance, or quality of fur produced by foxes receiving the various rations. Though the pups given the raw meat showed slightly better growth than those fed partly on the beef meal, the advantage was offset by the difference in feeding costs. During the first year the saving thus obtained on each pelt produced was approximately 40 percent, calculated on the basis of the pup increase obtained by the vixens on the two diets.

In similar experiments with martens and minks no apparent difference was evident in appetite or health or in general condition of the fur.

STUDIES IN COLOR INHERITANCE

New data obtained from breeding experiments in color inheritance of foxes have tended to strengthen the theory that the inheritance of red, cross, and black color patterns is controlled by two Mendelian factors. Modifying factors are involved, however, that cause variations in the relative extension of the red and black color in the cross-fox phenotype. Four pairs of purebred Alaskan black pups and one pair of adult standard silver foxes were recently purchased for use in further studies to determine the genetic basis of silvering and the relationships between the various degrees of silvering, and also to evolve methods of breeding that will insure control of gradations.

MARTEN-BREEDING EXPERIMENTS

A third generation of pen-raised martens was born in April at the fur animal experiment station, where the first authentic record was made of pen-raised martens producing and raising a litter in captivity. The marten-breeding experiments have not only established the fact that breeding is in July and August and that the gestation period is between 7¾ and 9½ months, but they have demonstrated in three instances that litters are produced consecutively.

STUDIES AT THE RABBIT EXPERIMENT STATION

EXPERIMENTS IN FEEDING YOUNG RABBITS

There is a potential market of several million dollars in rabbit skins in the United States, now largely supplied by foreign countries.

A series of experiments was partially completed at the United States rabbit experiment station, at Fontana, Calif., in the feeding cost of developing domestic rabbits from weaning age (8 weeks) to 6 pounds in weight on 13 different rations. A summary of the completed groups was presented by a Bureau representative before the national convention of the American Rabbit and Cavy Breeders Associations at Chicago, and was later issued as a mimeographed leaflet (Bi–1304), Feed Requirements in Raising Rabbits to a Weight of 6 Pounds. This summary of experiments with 263 animals (all New Zealands), the individual weights of which were recorded weekly, showed that it required 6.83 pounds of feed, 60 percent of it alfalfa hay, to produce 1 pound of gain in live weight between weaning age and a weight of 6 pounds. This is in contrast to the requirement for does and young of only 5.83 pounds of feed to produce 1 pound of live weight up to weaning age. A summary of this latter experiment was presented in a mimeographed leaflet (Bi–1294), Feed Costs of Producing Young Rabbits to Weaning Age, issued during the first part of the year. A new Farmers' Bulletin No. 1730, Rabbit Production, was in press at the close of the year, and there was issued as a mimeographed leaflet (Bi–1317), A Feeding Schedule for Rabbits.

A new experiment initiated during the year designed to test the desirability of weaning rabbits at 5, 6, or 7 weeks of age instead of at 8 weeks, which is the usual practice. An article was prepared on Rabbit-raising Profits Materially Influenced by Age at Marketing, and published in the Yearbook of Agriculture, 1934 (pp. 305–306).

Accurate production records enabled the United States rabbit experiment station to record a doe that produced 106 pounds of 8-week-old rabbits in 1 year. The progeny of this doe have been reserved for intensive close breeding. A homogeneous strain of this kind should materially enhance the experimental work through the elimination of many of the variable types.

Both cottonseed meal and sesame meal have been included in an experiment testing the relative value of protein supplements in feeding rabbits. Another experiment has for its purpose the study of the effects of supplying the feed in pellet form as a means of controlling the so-called "bloat", which has caused heavy losses in rabbits on the west coast. A mimeographed leaflet (Bi–1286), Observations on So-called "Bloat" in Rabbits, was issued during the year.

OTHER STUDIES AT THE RABBIT STATION

The station is now well equipped with all-metal hutches so made that individual feeding records can be kept on each doe and her litter. An all-metal nest box has also been designed. Metal construction greatly improves the sanitary conditions in the rabbitry. The other lines of investigation at the station are being continued. A mimeographed leaflet (Bi–1292), Pertinent Facts on the Angora Wool Rabbit, was issued during the year.

STUDIES OF FACTORS INFLUENCING THE PRODUCTION OF PRIME SKINS

Through the cooperation of raw-fur dealers the rabbit skins produced at the station were graded according to the purpose for which they could be used and are now being carefully studied through the cooperation of the Technical Association of the Fur Industry. Further detailed studies will be made after dressing and dyeing. Though nothing definite can be reported at this time as to the factors influencing the production of prime rabbit skins, indications are that in order of importance these factors are (1) heredity, (2) season in which skin is produced, (3) age of rabbit when skin was taken, and (4) kind of feed supplied. Definite information along these lines is of importance not only to the rabbit breeders but also to the fur trade.

MUSKRAT INVESTIGATIONS

During the year the muskrat investigation work was moved from Church Creek to the Blackwater Migratory Bird Refuge, both in Dorchester County, Md., and at the new site all-metal breeding pens were constructed. The experiments have demonstrated that at the prices now prevailing it is not profitable to undertake the production of these animals in small enclosures, as the investment in equipment, feed, and labor is greater than can be realized from the sale of pelts.

Information on the breeding habits of muskrats, however, can be obtained only by confining the animals in pens, so that conditions can be rigidly controlled. Research on the subject was well under way when unfortunately a hurricane devastated the entire area, drowning practically all of the animals. Since the muskrat is the most important American fur animal, there is pressing need for gathering fundamental information on the length of the gestation period, the number of litters produced each year, the number of young per litter, and the possibilities of improvement in the quality and density of fur by stocking after selective matings.

The appointment of the supervisor of the fur station on the Blackwater Refuge was terminated at the close of the year. This work had been financed cooperatively by the University of Maryland, the Conservation Department of Maryland, and the Bureau of Biological Survey. During the past year the Bureau financed the project alone, but reductions in appropriations made its discontinuance necessary. On the basis of the work undertaken, however, two extensive reports on muskrat production in captivity and in the wild have been prepared for publication.

The results of the past year's work on muskrats show that pelts trapped late in winter and early in spring are at the apex of condition and that from

this time on their value deteriorates. This prime period will vary slightly, depending on the place of trapping. These findings are exceedingly valuable to State officials responsible for formulating fur laws, for it furnishes them basic and conclusive information on which to recommend or prescribe the open seasons for trapping. Giving due consideration to primeness of fur and to breeding seasons not only aids in conserving the fur supply but also increases the value of the pelts taken. A revised edition of a mimeographed leaflet (Bi–1060), Raising Muskrats, was issued during the year.

Muskrat farmers in Delaware having raised serious objections to the drainage of adjacent marsh areas in mosquito-control operations, the executive officer of the Mosquito Control Commission appealed to the Bureau for cooperation in making investigations concerning the effect of drainage on the muskrats' food supply. Representatives of the Bureau visited Lewes, Del., and arranged to conduct necessary experimental work. Areas definitely surveyed have been set aside on which the water levels can be fluctuated at certain seasons of the year, and careful observations and records are being made as to the effect of the changes on muskrat food. Practically all the aquatic plants on which muskrats feed have been indentified in these experimental areas, and several plantings of cattails have been made. Drainage operations affecting areas suitable for muskrat production were temporarily suspended pending a report on the muskrat-food investigations.

COOPERATIVE STUDIES

ESTIMATING PRIMENESS OF PELTS

That the existing methods of estimating primeness of fur are not dependable has long been recognized by the Bureau, and lack of exact knowledge on the subject has been largely responsible for the great quantities of unprime furs that flood the market. Studies of the morphological and physiological factors involved have been undertaken and plans tentatively made for broadening the field of research. Investigational work by intrabureau cooperation was begun on the Upper Mississippi River Wildlife and Fish Refuge; the Blackwater Migratory Bird Refuge on the Eastern Shore of Maryland; the Bear River Migratory Bird Refuge, in Utah; and the Crescent Lake Migratory Bird Refuge, in western Nebraska; and plans were made to include other Federal refuges in the study. A small minkery and rabbitry have been constructed at the Blackwater refuge to compare findings from work at the fur animal experiment station, at the rabbit experiment station, and on Federal wildlife refuges.

KARAKUL-FUR INVESTIGATIONS

In a cooperative-project agreement with the Bureaus of Animal Industry and Home Economics on Karakul-fur investigations, 35 lambs ranging in age from 1 to 7 days were pelted during the spring and the raw pelts carefully inspected and graded, first by Bureau specialists and then by expert buyers of raw Karakul-sheep skins in New York, where they were dressed, dyed, regraded, and valued under present market conditions. The lamb pelts produced from purebred Karakul sheep were declared the most valuable, and a considerable number of pelts produced by crossbreeding with other sheep were also found marketable.

FACTORS INFLUENCING QUALITY IN FURS

A cooperative agreement was entered into with the Technical Association of the Fur Industry to obtain information on factors influencing the quality of fur in various pelts. At a meeting of the association, a representative of the Bureau read a paper on Conservation and the Molt Cycle, and in the June issue of the journal of the association there was published an article written cooperatively on Seasonal and Nutritional Studies on Animal Peltries, to make available the data thus far obtained.

PUBLIC WORKS ACTIVITIES ON FUR-ANIMAL EXPERIMENT STATIONS

The Public Works projects at the Bureau's fur-animal and rabbit experiment stations were practically completed before the close of the fiscal year. The erection of a new rat-proof feed-storage building at the fur-animal experiment

station makes it possible to purchase feed in larger quantities, thereby effecting a saving in maintenance costs. Other work there has increased the facilities for handling the animals. At the rabbit experiment station the new equipment provided included 192 all-metal hutches, which not only are ideal for experimental rabbit raising but are suitable also for commercial production. At the fur-animal station on the Blackwater Migratory Bird Refuge, a large unit of all-metal pens for muskrats, a small minkery, and a rabbitry were erected. The men employed on these projects, all of whom were selected from local relief lists, showed an appreciative interest in their work and on the whole rendered excellent service.

WILDLIFE DISEASE CONTROL

RELATIONSHIP OF DISEASE TO WILDLIFE POPULATIONS

Through a continuation of the work begun several years ago many important facts relating to wildlife disease conditions have been developed. In regions where losses occur periodically, definite areas with abundant game population have received detailed attention. In several of these test areas, tularemia, the most commonly encountered ailment, appears to have decimated the cottontail rabbits a year ago, while on the same areas the snowshoe hares and the grouse continued to increase. Through the process of trapping and examining large numbers of snowshoe rabbits and grouse, conclusive evidence is found that many had been affected with tularemia, indicating that these species are moderately resistant to some strains of the tularemia organism to which the cottontail rabbit readily succumbs.

Since, however, snowshoe rabbits and grouse are frequently found dead or affected with virulent strains of the tularemia organism, it is evident that under certain unknown conditions this disease does attack these forms. Cultures isolated from birds regularly show a lower virulence for laboratory test animals than is observed in those taken from mammals. The bird strains, however, when passed through a series of test animals, assume a more virulent nature, resembling the usual cultures taken from mammals.

In efforts to define the causes that periodically remove large portions of wildlife populations, a close study has been made of ticks, fleas, and other parasites capable of spreading destructive infections. These studies have disclosed a great increase in the abundance of ticks over that of a year ago. In one district the average tick population per snowshoe rabbit in the spring months was 2,110. This number represents an increase of 300 percent over those present last year. With this great number of blood-sucking parasites capable of transmitting infectious disease, a close study is being made to learn what part they may play in the actual destruction of wildlife. Already reports are being received of localized losses.

During the past year two obscure diseases of important game species have been studied. One of these, ulcerative enteritis, which has frequently been known to cause disastrous losses in quail and grouse on game farms, was found to occur also in wild ruffed grouse. The other, which is manifest in the form of horny growths on cottontail rabbits, has been shown to be caused by a filtrable virus. This disease is transmissible without difficulty by laboratory technic and is also doubtless spread very readily in the wild, since many individuals have been observed in the affected district. Efforts are being made to determine the relationship between such pathological conditions and game losses. An article was prepared for the Yearbook of Agriculture, 1934 (pp. 232–234), under the title "Game and Other Wild Species Suffer Heavy Losses from Disease."

FUR-ANIMAL DISEASES

Through the financial aid of a private fur company, a well-equipped fox ranch, where actual tests on disease prevention can be carried out, has been placed at the disposal of the cooperative organization of the Bureau and the University of Minnesota. Heretofore some of the treatments recommended after successful preliminary trials under well-controlled laboratory supervision failed to be completely satisfactory under practical ranch conditions. With this recent addition to the regular facilities the scientific workers will be able to give new products thorough tests before releasing them to the public. Frequent reports are received on the efficacy of the treatments and preventive meas-

ures already developed and recommended by this Bureau, and some conditions formerly considered serious are now regarded as of minor importance.

Special attention has been given to the relation of some of the disastrous disease outbreaks on fur farms to those occurring in the wild, including fox encephalitis and pseudotuberculosis.

RELATIONSHIP OF WILDLIFE DISEASE TO HUMAN BEINGS

Studies have been made during the past year of several outbreaks of diseases in wild forms, including rabies, spotted fever, and tularemia, which are of special importance because they are communicable to human subjects and domestic animals. Information was furnished local inquirers on methods for checking the spread of these diseases.

POLLUTION OF WATERS

Dumpage of oil and other injurious forms of waste into public waters continues to menace waterfowl, and several instances were brought to the attention of the local officials who have authority to prevent these destructive practices. Lead poisoning in waterfowl is evidently increasing through the pollution of feeding areas with shot. The details of this condition have been placed in the hands of metallurgical chemists with a view to experimentation in developing a nontoxic type of projectile for use in wildfowling.

During the year Technical Bulletin No. 411 was issued on Western Duck Sickness, a Form of Botulism, based on survey studies made in 1929, 1930, and 1931 on western marshy areas and saline lakes, where the disease has taken devastating toll of waterfowl.

ACQUISITION OF LANDS FOR WILDLIFE REFUGES

The main work in refuge-land acquisition was this year directed to the completion of the contracts that had previously been made through the vesting of title in the United States to such lands as were under contract, and to the surveying, monumenting, and posting of the boundaries of the lands so taken. During the year, titles to 485 acres were conveyed to the United States for use as migratory-bird refuges under the Migratory Bird Conservation Act; 2,319 acres were acquired in the same manner under the provisions of the Upper Mississippi River Wildlife and Fish Refuge Act; and 325 miles of boundary lines were relocated and posted. So far as financial resources would permit investigations were conducted to determine refuge opportunities on public lands and whether lands acquired by the United States for some other purpose might serve also as wildlife sanctuaries.

REFUGES UNDER MIGRATORY BIRD CONSERVATION ACT

The creation of refuges for migratory birds through the process of acquisition by purchase was brought to a virtual standstill during the fiscal year 1934 for lack of funds. The Biological Survey recommended the creation, by Executive order, of two refuges, however, containing 136,624 acres. One of these, the Killcohook Migratory Bird Refuge, on the Delaware River, embraces 1,440 acres of land and water in Salem County, N. J., and Newcastle County, Del. The area is under the jurisdiction of the War Department and is being used by that Department in connection with the improvement of the channel of the Delaware River. It is in a zone where land prices are considerably higher than the limits at any time set by the Biological Survey for migratory-bird refuge areas and is in a region where it will serve a highly useful purpose in offering a safe resting and feeding place for ducks and geese in migration, and in providing an outdoor laboratory for studies of fur animals, particularly muskrats.

The Railroad Valley Migratory Bird Refuge, containing 135,184 acres in Nye County, Nev., previously temporarily withdrawn, was constituted a permanent refuge by an Executive order dated May 2, 1934. Funds were provided under the National Recovery Act to improve the area by developing and impounding an artesian water supply, and the work is in progress. This refuge will provide a resting and feeding place in the center of an immense desert area.

On June 29 an option was taken for the purchase of 45,000 acres of land and water for establishing the White River Migratory Bird Refuge, in Arkansas, Monroe, Phillips, and Desha Counties, Ark. Departmental approval was given

in July 1934, and acquisition will be from funds made available in the F. E. R. A. land program. The area will serve as a resting ground for the waterfowl that traverse the Mississippi Valley flyway, the most common of which are mallards (about 80 percent of all), pintails, widgeons, and teals.

During the year 120 acres of land were conveyed by gift to the Biological Survey by the National Association of Audubon Societies for inclusion in the Charles Sheldon Wildlife Refuge in northwestern Nevada, thus solidifying and greatly enhancing the value of this sanctuary for antelope and other species.

Table 1 sets forth the present status of the refuge acquisitions under the Migratory Bird Conservation Act.

TABLE 1.—*Refuge areas acquired and approved for acquisition under the Migratory Bird Conservation Act program, to June 30, 1934*

State and county	Refuge	Areas approved by the Migratory Bird Conservation Commission for purchase and lease-purchase			Other areas acquired	Total
		Acquired by purchase	Pending title conveyance under purchase agreement	Total		
		Acres	*Acres*	*Acres*	*Acres*	*Acres*
Alaska	Semidi Islands				[1] 8,920	8,920
Arizona, Mohave	Boulder Canyon (see also Nevada).				[1] 312,687	312,687
California, Imperial	Salton Sea	8,982		8,982	[1] 36,578	45,560
Delaware, Newcastle	Killcohook (see also New Jersey).				[1] 586	586
Florida:						
Levy	Cedar Keys				[1] 224	224
Hernando	Chinsegut Hill				[2] 2,033	2,033
Jefferson, Taylor, and Wakulla.	St. Marks	19,313		19,313	[1] 16,298	35,611
Georgia, McIntosh	Wolf Island				[1] 538	538
Maine, Knox	Widows Island				[3] 12	12
Maryland, Dorchester	Blackwater	8,241		8,241		8,241
Montana, Cascade and Choteau	Benton Lake				[1] 12,235	12,235
Nebraska, Garden	Crescent Lake	40,609		40,609	[1] 173	40,782
Nevada:						
Clark	Boulder Canyon (see also Arizona).				[1] 346,443	346,443
Churchill	Fallon				[1] 17,902	17,902
Nye	Railroad Valley				[1] 135,184	135,184
New Jersey, Salem	Killcohook (see also Delaware).				[1] 854	854
New Mexico, Chaves	Roswell				[1] 1,962	1,962
North Carolina, Hyde	Swanquarter	15,341	151	15,492		15,492
North Dakota, Burleigh and Kidder.	Long Lake	5,292		5,292	[1] [4] 1,810	7,102
Oklahoma, Alfalfa	Salt Plains				[1] 19,452	19,452
South Carolina, Charleston	Cape Romain	22,452		22,452	[1] [5] 31,613	54,065
Utah, Box Elder	Locomotive Springs				[1] 1,013	1,013
Washington, Grant	Lenore Lake				[1] 4,682	4,682
Wyoming:						
Albany	Bamforth Lake	965		965	[1] [4] 1,199	2,164
Do	Hutton Lake	1,248		1,248	[1] [4] 460	1,708
Total		122,443	151	122,594	952,858	1,075,452

[1] By Executive order or proclamation.
[2] By gift.
[3] By act of Congress.
[4] By lease without option to purchase; acquisition approved by the Migratory Bird Conservation Commission.
[5] By cession.

WILDLIFE REFUGE ADMINISTRATION

The establishment of two wildlife refuges during the year brought the number now supervised by the Bureau of Biological Survey to 104.

BIG-GAME PRESERVES

In accordance with the policy of preventing overgrazing of the ranges, surplus big-game animals in the herds were removed during the season 1933–34, some of the buffalo, elk, and deer being donated for use as meat to needy Indians at nearby agencies. The number of big-game animals on the four fenced enclosures was 1,558, an increase of 159 over the number last year. The numbers of the various species are shown in table 2.

TABLE 2.—*Animals on fenced big-game preserves maintained by the Bureau of Biological Survey*[1]

Preserve	Buffalo	Elk	Antelope	Mountain sheep	Deer		Total[2]	Young born in calendar year 1933[3]		
					White-tailed	Mule		Buffalo	Antelope	Mountain sheep
National Bison Range, Mont.	530	[4]141	-------	60	[4]29	[4]108	868	94	-------	18
Wind Cave Game Preserve, S. Dak.	258	[4]58	[4]58	-------	2	[4]18	394	47	7	-------
Niobrara Game Preserve, Nebr.	140	59	12	-------	3	1	215	26	2	-------
Sullys Hill Game Preserve, N. Dak.	25	[4]46	-------	-------	10	------	81	3	-------	-------
Total	953	[4]304	[4]70	60	[4]44	[4]127	1,558	170	9	18

[1] With the exception of those of young born, figures are for June 30, 1934.
[2] Including estimates.
[3] Young of elk and deer omitted as in most cases only estimates could be made; during the calendar year, however, 81 elk calves, and 35 mule deer and 14 white-tailed deer fawns were seen on the preserves.
[4] Estimated.

NATIONAL BISON RANGE

A mild and rainy winter made the grass ripen about 3 weeks earlier than usual on the National Bison Range in Montana, and at the end of the year the forage was in the best shape it has been in during the past 3 years. To avoid depletion of the forage through overgrazing, surplus animals were donated to the Flathead Indian Agency and removed from the range. The surplus elk, in 1933, furnished for stocking an area in the State of Washington were liberated on an area adjacent to the Mount Rainier National Park instead of, as reported last year, on the park lands proper.

There have been born this season 67 buffalo calves and 19 mountain-sheep lambs, but 10 of the calves and 1 lamb died before the end of June; 15 elk and 25 deer fawns have been seen. The albino buffalo, born last year, is thriving and continues to be a great attraction for visiting tourists.

Improvements on the preserve under P. W. A. funds included the construction of 3 towers, 19 wooden tanks, and 3 reservoirs for the conservation of the water supply, as well as bridges, culverts, roads, and a telephone line.

WIND CAVE GAME PRESERVE

A mild winter left the animals on the Wind Cave Game Preserve, South Dakota, in excellent condition, with the exception of a few old or injured individuals. Increases included 50 buffalo calves, 3 elk calves, and at least 2 antelope fawns. Surplus animals disposed of included 27 buffalo for breeding and exhibition purposes, 20 of which were transferred to the nearby Custer State Park. An excellent forage crop was produced in the summer of 1933, but this year's crop was reduced below normal by the exceedingly dry spring and summer.

Improvements under allotment of P. W. A. funds included the construction of an exhibition pasture for the buffalo, fence wings for the east pasture, capturing corrals, roads, and trails to facilitate the protection of the animals and the administration of the area, and general repairs to the game fences.

ELK REFUGE

The winter was exceptionally mild in Jackson Hole, Wyo., and the few snows soon melted in the valley, leaving the meadow and pasture lands bare most of the time. It was the fourth winter since the elk refuge was established in 1912 that it was not necessary to feed the elk. The first elk appeared on the refuge on October 16, but it was not until snow fell in the first week in December that the animals began to migrate to the valley in large numbers. By the end of December approximately 4,000 had gathered on the refuge and in the nearby foothills, but not more than 4,500 wintered there. The meadow and pasture lands furnished sufficient forage, and the animals came through the winter with comparatively little loss from any cause. Probably not more than 650 tons of hay, about a half of the normal crop, was produced this season, and at the end of the year, with the soil dry to a depth of several feet, there was so short a crop of forage on the open ranges and pasture lands that if the coming winter should be severe there would be an acute feeding problem on the refuge and in the vicinity.

Improvements made with the P. W. A. funds allotted included repairs to buildings, the construction of 2 barns, 5½ miles of fence, 3 corrals, 4 miles of telephone line, and 6 sheds for storing emergency rations. A fire-prevention system was installed and the irrigation system extended and reconditioned.

SULLYS HILL GAME PRESERVE

The big-game herds on the Sullys Hill Game Preserve, North Dakota, have been increased by the birth of 5 buffalo calves, 2 white-tailed deer fawns, and at least 10 elk calves. During the fiscal year 13,893 persons with 2,475 cars visited the preserve.

About half of the 500 acres of timberland on the preserve was thinned out during the winter and early spring under a C. W. A. project, which provided work for unemployed people and furnished the needy with 568 loads of surplus wood. Improvements under P. W. A. funds included the construction and repair of roads and trails, the erection of a machine shed, digging a ditch to carry water during dry years to a small lake in the preserve, and the removal of a large accumulation of silt from the lake. Also a contract was let for the completion of an interlocking steel-piling dam to preserve the level of Sweetwater Lake.

NIOBRARA GAME PRESERVE

The big-game animals at the Niobrara Game Preserve, Nebraska, have been increased by 30 buffalo calves, 2 antelope fawns, and at least 12 elk calves. Surplus animals disposed of included 15 buffalo and 18 elk.

Extensive improvements under P. W. A. and E. C. W. funds included the construction of 5 miles of interior big-game fence, 7 miles of stock fence, and 16 miles of big-game fence enclosing 11 sections of land as a pasture for antelope, 6 large dams to create breeding and nesting areas for waterfowl, roads and trails in the north and south pastures, and 2 big-game exhibition pastures near headquarters. An excellent fire-prevention system is about completed, and a steel lookout tower has been erected.

CHARLES SHELDON WILDLIFE REFUGE

Continued drought conditions throughout the West were adversely affecting all animal life on the Charles Sheldon Wildlife Refuge and adjacent parts of Nevada as the year closed. Livestock has recently been excluded from the refuge's 48 square miles, and in the areas free from the disturbance of improvement activities in progress the resulting beneficial effect on wildlife is apparent.

Antelope, accustomed to migrate east and south late in November or early in December, ranged on the refuge throughout the year, more than 1,200 being within the refuge in February and March. The numbers lessened in spring as the bands broke up, and drought conditions and improvement activities left only approximately 400 in the region at the end of the fiscal year. An encouraging feature was the increase in sage grouse over the numbers observed in 1933. Mule deer are holding their own well in this section, but

drought conditions seriously diminished the numbers of migratory insectivorous and song birds.

Improvements made with P. W. A. funds included the construction of 28 miles of stock fence, an observation tower, and new headquarters buildings, and work on water conservation.

BIRD REFUGES

NEW REFUGES ESTABLISHED

Two new wildlife refuges, chiefly for the protection of migratory birds, were created and placed under the jurisdiction of the Biological Survey during the year. These were the Killcohook and the Railroad Valley migratory-bird refuges (p. 17).

BIG LAKE BIRD REFUGE

Water conditions in the spring were favorable for the ducks on the Big Lake Bird Refuge, Arkansas. Mallards, pintails, and black ducks were present in normal numbers and remained well into May. Scaups, ringneck ducks, and gadwalls were less abundant than usual. Blue-winged teal and shovelers appeared in May, but also in reduced numbers. Goldeneyes, buffleheads, canvasbacks, redheads, American widgeons, and green-winged teal were scarce. Conditions were suitable for wood ducks and hooded mergansers, and a normal number of these birds nested and raised broods of young. A goodly number of sandpipers, woodcock, and killdeer were observed during the spring. Egrets, herons, and bitterns also frequented the area, and large numbers of wood ibises were present. Thousands of migratory insectivorous birds visit the refuge, and many remain the year round.

Under an allotment of P. W. A. funds the refuge boundary lines have been newly surveyed, and at the close of the year the construction of a new headquarters house and a fire and observation tower was under way. Surveys also were completed, and plans were maturing for water-control improvements that will restore the lake to its original levels.

LAKE MALHEUR BIRD REFUGE

Practically the entire bed of Lake Malheur, Oreg., was dry by late spring, and the only water entering came from one large spring. A good portion of this water is being diverted to hay lands, however, and does not reach the lake. The area within the refuge not grazed is producing a dense growth of foxtail grass, and part of it has been cut for hay by neighboring ranchers. Extreme scarcity of water in the refuge discouraged much waterfowl nesting, but a number of ducks and geese were resting in a spring at a nearby homestead. The case of the *United States* v. *The State of Oregon*, to determine ownership of lands in the lake bed and vicinity was still pending at the close of the year, the special master appointed to hear the case not having made his recommendations to the supreme court.

BLACKWATER MIGRATORY BIRD REFUGE

During the period the C. C. C. camp was on the Blackwater Migratory Bird Refuge, Maryland, the work accomplished included the construction of roads and trails, 3 lookout towers, a bridge, 2 wells, and a telephone line, improvements to headquarters, and the removal of fire hazards from an extensive area. Since the extremely cold weather in February and March, when all the waterways froze and made it difficult for waterfowl to find food, there has been no great number of ducks on the refuge at any time, and only about half as many were there last spring as a year ago. Conditions for the nesting waterfowl were not quite so favorable as in the previous year, some areas having been burned over, and a hurricane in August and high salt tides having destroyed many trees, shrubs, and nesting cover.

CRESCENT LAKE MIGRATORY BIRD REFUGE

Approximately 2,500 pairs of ducks, 2,500 pairs of grebes, and 3,000 pairs of coots stayed on the Crescent Lake Migratory Bird Refuge, Nebraska, during the summer of 1933, a decided increase over the number the previous year. Ob-

servations in 1934, however, indicate a decrease of about 10 percent in nesting waterfowl, due in part to the lower water levels and constantly diminishing water areas. The country in and around the refuge, however, is better supplied with water than are other parts of the sandhill section. On June 30 most of the lakes were down to the lowest point reached in the fall of 1933, but there was still considerable water and an abundance of aquatic waterfowl foods. Some lakes showed a slight increase in waterfowl, though others were severely depleted.

At the height of the fall migration the last of October a bird census indicated about 40,000 ducks on the refuge, and old residents of the locality stated that they had seen more mallards this year than for several years. A snowstorm and accompanying cold weather on November 4 closed all but two of the lakes, and all but about 4,000 of the ducks left the refuge, though a few days later many returned when the lakes opened up again. By January 1 all lakes were frozen over, and the ducks were gone. The open-winter conditions brought back the first mallards around the first of February, at least a month earlier than usual, and about March 25 more than 35,000 ducks were on the area. Large numbers of snow geese stopped during the spring flight. Curlews, avocets, and upland plover showed an increase of about 10 percent over last year, but willets, lesser yellowlegs, and sandpipers decreased about 20 percent. The increase of Chinese pheasants moves to the farming country to the south, leaving about the same number of birds on the refuge each year. During the winter 26 pheasants were fed at the headquarters. Muskrats are on the increase in many of the lakes, and coyotes are plentiful.

With P. W. A. and E. C. W. funds a 45-foot steel lookout tower was erected on a high hill, a new headquarters building is being constructed, a telephone line from Alliance, Nebr., to the headquarters was practically completed, 4 nesting areas on the east side of the refuge were fenced, 186 acres of lowland were planted to trees, and road improvement to headquarters made.

ST. MARKS MIGRATORY BIRD REFUGE

Improvements made by C. C. C. workers at the St. Marks Migratory Bird Refuge, Florida, during the year included the construction of about 14 miles of truck trail, 19 miles of telephone line, a machine shop, lookout towers, a fire-prevention system, a wharf, and repairs to existing buildings, and surveys.

SWANQUARTER MIGRATORY BIRD REFUGE

A great number of canvasback ducks and many geese and swans were observed at various times during the winter on the Swanquarter Migratory Bird Refuge, North Carolina. With the aid of the C. C. C. camp established on this refuge, a headquarters building and an artificial channel some 800 feet long across Judith Island were constructed, a 100-foot tower built, and two 45-foot towers have been erected or are under construction.

UPPER MISSISSIPPI RIVER WILDLIFE AND FISH REFUGE

The protracted drought established for the second successive year a low-water record at many points in the Upper Mississippi River Wildlife and Fish Refuge. The many valuable lakes, marshes, and sloughs remaining dry for part of the year greatly limited the crop of wild-fowl food and reduced the attractive habitats for waterfowl. About the usual numbers of wild ducks passed over during the fall migration of 1933, and apparently a larger number of wild geese were killed along the river than normally, the birds concentrating on smaller water areas and thus enabling the hunters to get within closer range. Instead of the concentrated migration of geese similar to that of the preceding year, the spring migration began at a time when water conditions were unfavorable and the birds were hard pressed for both food and resting grounds. A substantial rise in water levels following an extremely heavy snowfall shortly after the arrival of geese flooded much of the bottom land, to the material advantage of the birds. There appeared to be an abundance of food, and the birds concentrated in large numbers throughout the length of the refuge wherever conditions were at all attractive.

The concentration of ducks along the Mississippi River flyway made an unusually heavy migration through the refuge during the spring of 1934. Pintails and mallards again predominated, and wood ducks also were relatively abundant, but reports indicate that the drying up of lakes and marshes in these areas caused them to abandon several of their former breeding grounds.

An investigation during the past spring to ascertain the approximate number of breeding waterfowl on the refuge brought disappointing but not surprising results. Low water levels and a rank growth of vegetation attracted large numbers of upland birds to the bottom lands, and ring-necked pheasants and quail especially have established themselves there in substantial numbers. A number of deer also wintered in the refuge along Black River section in La Crosse County, Wis.

Thirty-one fires burned over a total of 7,591 acres on the refuge during the year. Under the current fire-detection system, more reports are being obtained, and observers are reporting them more promptly than in the past.

The unprecedented drought throughout the length of the refuge resulted in a greatly augmented number of requests for permission to graze domestic stock on refuge lands. Immediate steps were taken to promulgate regulations to prevent overgrazing and other damage, and the restricted grazing authorized was only on areas carrying a minimum supply of game. Because of the strictly limited grazing allowed, there was little or no interference with the wildlife.

BEAR RIVER MIGRATORY BIRD REFUGE

The Bear River Migratory Bird Refuge, Utah, is each year attracting increased numbers of waterfowl, and additional species are being added to the list of birds observed on the protected area. Numbers of waterfowl, particularly ducks and geese, remained on the refuge during the entire winter season, which was exceptionally open. Worthy of special note is the fact that about 6,000 whistling swans remained as compared with 1,500 to 2,500 in previous years.

Duck sickness was far less extensive than in 1932, when there was a serious outbreak. In 1933 it was first in evidence on August 5 and continued until September 27, when the counting of sick and dead birds was discontinued. During the period of the count 488 dead birds were found, and 2,488 showed evidence of being affected. In 1932 on the refuge proper, 32,769 dead ducks were gathered up and disposed of, and it was estimated that 250,000 or more died outside, in the area known as "Willard Spur."

On the public shooting grounds authorized on the refuge by the Bear River Migratory Bird Refuge Act, there was a considerable increase in the number of hunters during the shooting season of 1933, but the average bag was less than in 1932.

Improvements on the refuge made possible by the allotment of P. W. A. funds included the completion of approximately 14 miles of a 4-wire stock fence along the north and west sections, erection of 2 steel observation towers, grading of 22 miles of dike roads, and dressing the main dike for a distance of about 13 miles. The top of the dikes was graveled for approximately 18 miles, and considerable work was done in water control.

ADMINISTRATION OF LAWS FOR WILDLIFE CONSERVATION

On March 6, 1934, the President approved, to become effective on June 16, 1934, the Migratory Bird Hunting Stamp Act, to which reference has already been made (pp. 2–3). Other statutes administered by the Biological Survey include the Migratory Bird Treaty Act of 1918; the Lacey Act of 1900, relating to interstate shipments and importations of wild birds and mammals; a law affecting animal life and property on Federal wildlife refuges; the Migratory Bird Conservation Act of 1929, authorizing establishment and administration of bird refuges; and, through the Alaska Game Commission, the Alaska Game Law of 1925.

ENFORCEMENT PERSONNEL

A reduction from 25 to 22 in the field force of United States game protectors caused by lack of funds necessitated the abandonment of 3 enforcement districts. The reorganization of field forces under the new Division of Game Management will furnish added supervision of law enforcement. Some of the proceeds from the sales of waterfowl stamps will permit the employment of more field agents, but an adequate financing of enforcement personnel is still one of the great needs in the control of law violations.

A mobile force of United States game protectors and Federal deputy game wardens was drawn from other districts to operate during the close season in the Middle West and give special attention to areas in the Mississippi River flyway. As a result of their concentrated action 78 out-of-season shooters were apprehended and many others put their guns back on the racks.

MEASURES TO CONSERVE WATERFOWL

The Advisory Board, Migratory Bird Treaty Act, met at Washington, D. C., on July 10 and 11, 1933. A public hearing was held on August 28 of that year on a proposed baiting regulation. The Survey was requested by the Board to make a study of baiting practices before its 1934 meeting (p. 9). The hunting seasons for 1933–34 were practically the same as in the previous year, but jacksnipe were given the same seasons as waterfowl. The season on brant was closed on the Atlantic coast because of the shortage of the eelgrass (p. 9), while hunting of cackling geese was again permitted. The bag limit on wild ducks was reduced from 15 to 12 a day, of which not more than 8 of any one or 8 in the aggregate might be canvasbacks, redheads, scaups, ringnecks, teals, shovelers, and gadwalls. The possession limit on woodcock was fixed at 12.

Publications issued during the year on the enforcement of conservation laws included the annual bulletin on the game laws (Farmers' Bulletin 1717), the text of the amended regulations under the Migratory Bird Treaty Act, and of other Federal laws relating to game and birds (Service and Regulatory Announcements, B. S. 78), a poster (no. 52) giving the open seasons on migratory game birds, a mimeographed abstract of the fur-trapping seasons, the annual directory of Federal, State, and Canadian game protection officials (Miscellaneous Publication 166), and in the Yearbook of Agriculture, 1934, a table (514, p. 743) on hunters' licenses issued by States, with total money returns, for the seasons 1931 and 1932. There was also prepared in the Biological Survey during the year a poster on the new migratory-bird hunting stamp, for distribution to post offices, and a combined application and report form to be used in obtaining the stamps. Press statements were issued on the purchasing of the stamps and the purposes for which the funds obtained thereby would be expended.

LAW VIOLATIONS AND PENALTIES

CASES UNDER MIGRATORY BIRD TREATY ACT

There was an increase of 100 over the preceding fiscal year in the number of cases of violation of the Migratory Bird Treaty Act reported by the Department for prosecution, a relatively slight decrease in convictions obtained, and an increase in the number of cases disposed of (table 3). In 56 cases action was not recommended on account of lack of evidence, youthfulness of the accused, or other satisfactory reasons. Fines and costs ranging from $1 to $200 and aggregating $5,172 were assessed in the Federal courts. Jail sentences were imposed as follows: 1 hour in custody of marshal, 1; 1 day in custody of marshal, 2; 1 to 18 days' confinement, 9; 30 days, 3; and 60 days, 1. Sentences were suspended in 3 cases for 5 years each; in 1 case for 2 years; and in 11 cases defendants were placed on probation. Jail sentences ranging from 30 days to 12 months were suspended in 6 cases. Six cases tried before a jury resulted in verdicts of guilty. Seizures of migratory game birds had an estimated value of $800, and such birds as could be utilized for food were donated to hospitals and other public charitable institutions.

TABLE 3.—*Cases of violation of the Migratory Bird Treaty Act disposed of during the fiscal year and cases still pending June 30, 1934*

Cases disposed of	Number	Cases pending	Number
Convictions	274	Pending from former year	344
Dismissals	105	New cases	452
Verdicts of not guilty	15		
No bills found	5	Total	796
Nol-prossed	32	Disposed of	447
Death of accused	1		
Denied leave to file	8	Pending at end of year	349
Statute of limitations	3		
Stricken from docket	4		
Total	447		

For killing ducks in close season, 3 violators in California were each given the alternative of a fine of $200 or 90 days in jail, and 3 others in the same State received jail sentences of 18 days each. On the same charge 1 violator in Missouri paid a fine of $100, and 1 in Washington a like fine and costs of $72.30. Possession of ducks in close season brought a suspended sentence of a $100 fine and 6 months in jail to a violator in Maryland, and a similar case in Washington was disposed of by a 10-day jail sentence. In Georgia 2 cases of killing doves in close season were terminated by the imposition of 12-months' suspended sentences. One violator charged with killing sandpipers in Virginia was fined $100 and given 6 months in jail, the sentence being suspended; and in the same State 2 others charged with possessing geese in close season were sentenced to serve 60 days each in jail, but sentence was suspended for 2 years.

Other cases of violation of the Migratory Bird Treaty Act successfully disposed of during the year included possession of swans, 2 (in Maryland); killing wood ducks, 3 (in Georgia); killing ducks from motorboats, 3 (in Georgia); killing ducks and geese in excess of daily bag limit, 10 (6 in Louisiana, 4 in Florida); shooting ducks over more than 25 live decoys, 4 (in Missouri); and killing doves over baited fields, 45 (3 in Alabama, 42 in Georgia).

UPPER MISSISSIPPI RIVER REFUGE CASES

Three cases involving trapping on closed areas or during the close season on the Upper Mississippi River Wildlife and Fish Refuge were reported for prosecution; 2 were closed by jail sentences of 30 days each. Nine cases previously reported—4 involving hunting on closed areas, 4 for hunting raccoons, and 1 for carrying firearms in a closed area—were terminated; 3 fines of $15 were assessed, 5 cases were dismissed, and in 1 the grand jury did not return a true bill.

Of 34 cases involving violations of State game and fish laws on this refuge, 32 were disposed of—10 by fines and costs totaling $387.46; 10 by jail sentences, 5 by jury verdicts of not guilty, 4 by suspension of sentence upon payment of costs, 1 by a 6-months' jail sentence, 1 by abandonment of prosecution, and 1 by dismissal.

WILDLIFE RESERVATION TRESPASS ACT CASES

For violations of the law protecting wildlife and Government property on Federal reservations (sec. 84 of the Criminal Code), 3 cases were reported for prosecution. Two of these (both in Wyoming) were terminated by fines of $25 each.

INTERSTATE SHIPMENTS OF WILD MAMMALS AND BIRDS

Protectors working under the Lacey Act inspected records at raw-fur receiving centers in 11 States, and discovered evidence of many infractions of State game laws. Information regarding 4,118 shipments containing skins of fur-bearing animals illegally taken or shipped were transmitted to State game departments in 28 States. In 12 States 339 cases based on information originally furnished by the Survey were closed by fines and costs of $2,974. In 1,322 other investigations by the States it was determined that 1,207 shipments were lawfully made and in 115 others that prosecution would be inadvisable. The game departments of 28 States were furnished evidence regarding 342 cases involving violations other than illegal interstate shipments of skins of fur-bearing animals. As a result of these prosecutions, fines and costs in State courts amounted to $8,779.23.

WILDLIFE CONSERVATION IN ALASKA

LAW ENFORCEMENT

Few changes were made in the regulations for the 1934–35 hunting and trapping seasons under the Alaska Game Law. Reduction of funds in the previous year necessitated dropping one of the force of 10 wardens, and a further reduction has brought the active field force to 7 and reduced the executive office staff. Curtailment of enforcement patrols has tended to increase violations in outlying areas. An allotment of $195,700 by the Public Works Administration has, however, provided for urgently needed equipment for the

Bureau's work in Alaska through the operating agency—the Alaska Game Commission. Of this sum, $160,800 was allotted for building and equipping six patrol boats and the remainder for the construction of docks, floats, small storehouses, and the administrative buildings for field offices and wardens' living quarters.

WILDLIFE RESTOCKING PROJECTS

An allotment of $25,000 provided through the Governor of Alaska by the Federal Emergency Relief Administration to carry out a program of wildlife restocking work authorized by the Civil Works Administration, enabled the Alaska Game Commission to push forward the Territorial program of restocking depleted areas with game and fur animals. The funds were primarily for unemployment relief among native Indians and Eskimos, an average of about 65 of whom, including Aleuts and halfbreeds were engaged in their communities from January 1 to March 31. Trained foremen were taken from the relief rolls and with one exception were registered guides. Alaska game wardens supervised the operations.

The capture, handling, and shipment of the animals in subzero temperatures presented a problem never before experienced in this type of work, and the men had to be housed, in the dead of winter, in tent camps, many of them in 3 or more feet of snow. Nevertheless, 558 of the 586 snowshoe rabbits captured in the interior of the Territory were liberated on the northeastern end of Kodiak Island, 39 Sitkan black-tailed deer taken in southeastern Alaska were liberated near Yakutat and on Kodiak Island, and 22 martens from the mainland of southeastern Alaska were placed on the Prince of Wales and Baranof Islands.

The herd of 23 buffalo transplanted to Alaska 5 years ago from the National Bison Range, has thrived and more than doubled in number, according to reports received in December. The animals, observed in two herds on the Jarvis Creek flats southeast of Fairbanks, numbered 60, including calves and yearlings.

A survey was made of the moose range on the Kenai Peninsula to determine the number of these game animals present and their relationship to the available forage.

ATTRACTIONS OF WILDLIFE FOR TOURISTS

Recent publicity regarding the big bears has increased the number of sportsmen and noted big-game hunters who plan to visit the Territory this year. There is a growing feeling in the Territory that the bears thus constitute a valuable resource, but many prospectors, fishermen, and others look upon them as potential enemies to be shot at sight. Active patrols are especially needed during spring and summer, when the bears come to the beaches and mouths of streams for salmon, but the enforcement difficulties are increased by lack of funds.

IMPORTATION AND OTHER PERMITS ISSUED

PROHIBITED SPECIES EXCLUDED UNDER THE LACEY ACT

Since the enactment of the Lacey Act in 1900 no forbidden species of bird or mammal has established a foothold in the United States, and the English sparrow and starling, then established, have not been augmented by any importations.

So far as known, no prohibited species was entered during the year. An importer in San Bernardino, Calif., who had received nine Chinese crested mynas from the Orient, was notified that the birds should either be returned or destroyed, and the birds were immediately killed.

BIRDS ENTERED UNDER PERMIT

Importation permits issued during the year numbered 1,186, an increase of 274 over the number in 1933. Shipments inspected decreased from 267 to 175. Twenty-six additional permits were issued at Honolulu, Hawaii, for the entry of 346 miscellaneous birds. There were also imported at San Juan, Puerto Rico 636 miscellaneous birds. The total number of all foreign birds imported was 263,735, a decrease of 47,301 from the number imported last year. Included in the total were 207,701 canaries, 1,911 parrots, 13,611 Mexican quail, 8,000

valley quail, 2,300 Hungarian partridges, 900 pheasants, and 29,312 miscellaneous birds.

The Bureau during the year ruled that ships' crews are not exempt from the customs regulation permitting passengers to bring in with them as baggage, without permit, not to exceed 5 canaries or 5 parrots, and this view was sustained by subsequent ruling of the Treasury Department.

For failure to obtain an importation permit from this Bureau within the time limit, a Philadelphia dealer in birds and other animals was assessed $50 on his bond.

The number of bobwhite quail imported from Mexico during the 1934 season was only 13,611, as compared with 22,110 last year, though prior to the opening of the season the Mexican Government had granted concessions to six individuals for the exportation of a total of 75,000 birds. The decrease was probably due in part to the fact that the Mexican Government, by resolution passed on March 12, 1934, prohibited the exportation of any quail from Mexico after March 31, because of a depletion of the species in certain agricultural sections, particularly on the northern frontier, thus shortening the season from the former 2½ months to 1½ months. All entries of these quail were made at the ports of Eagle Pass and Laredo, Tex., where inspectors of the Bureau of Animal Industry, cooperating with this Bureau, made examinations and issued permits. The quail were shipped mainly to 11 States, as follows: Texas, 3,469; Tennessee, 3,300; Indiana, 2,795; Kentucky, 1,500; Oklahoma, 800; Mississippi, 500; Alabama, 320; Florida, 260; New York, 200; Illinois, 100; and West Virginia, 100. The rest of the birds, numbering about 240, were distributed to Pennsylvania, Vermont, New Hampshire, North Carolina, Georgia, and California. The total number of bobwhite quail brought in since 1910 is approximately 727,000.

Eight thousand valley quail were imported by the California Fish and Game Commission from Baja California for stocking purposes in southern California.

This year no Hungarian partridges were imported from European countries, but about 2,300 were brought in from Canada, largely for stocking in North Dakota and South Dakota.

Three peuras, or common hill-partridges (*Arborophila torqueola*), and nearly 200 chukar partridges (*Alectoris graeca chukar*) were imported from India; 54 francolins (*Francolinus coqui*) from Benguela (Portuguese West Africa), and 23 other partridges, species unknown, from Colombia, South America.

More than 900 pheasants were imported during the year, comprising many species, and including among the more interesting, 19 copper pheasants (*Graphephasianus soemmerringii*), 13 Edwards pheasants (*Hierophasis edwardsi*), 2 Swinhoe pheasants (*H. swinhoii*), 4 Siamese crested firebacks (*Diardigallus diardi*), 2 ring-necked pheasants (*Phasianus colchicus torquatus*), and 1 Bornean pheasant (*Lophura ignita*), from Japan; and 19 tragopans (*Tragopan satyra*), 2 ring-necked pheasants (*P. colchicus torquatus*), 6 cheer pheasants (*Catreus wallichii*), 18 Koklass pheasants (*Pucrasia macrolopha*), 26 Impeyan pheasants (*Lophophorus impejanus*), 8 Kaleege pheasants (*Gennaeus leucomelanos*), and 6 golden pheasants (*Chrysolophus pictus*) from India.

Fewer canaries and other cage birds were imported this year than last. Parrots and parrakeets in comparatively small shipments are still being imported, though under the Public Health Service regulations birds of the parrot family less than 8 months old are not admitted, and occasional instances of parrot fever have been reported during the year. Four budgerigars refused entry for lack of the foreign sanitary certificate of origin called for in the regulations, were returned to Glasgow, Scotland, whence they were shipped, and about 4 weeks later were sent back with the required certificate.

Among the rare and more interesting birds imported during the year were 2 nanned geese (*Chenonetta jubata*), 2 Australian ducks (*Anas superciliosa*), 32 yellow-rumped finches (*Donacola flaviprymna*), and 7 spotted-sided finches (*Tavistocka guttata*) from Australia; 25 rice quail (*Coturnix* sp.), 24 baya weavers (*Ploceus philippinus*), and 2 silver-eared hilltits (*Mesia argentauris*) from India; 2 red-faced love birds (*Agapornis pullaria*) from Africa; 6 spur-winged geese (*Plectropterus gambensis*) from Benguela; 6 jackass penguins (*Sphenicus demersus*); 2 wood hoopoes (*Phoeniculus purpureus*), and 2 hammerhead storks (*Scopus umbretta*) from South Africa; 3 painted quail (*Excalfactoria chinensis*), 96 button quail (*Turnix* sp.), and 3 owl finches (*Steganopleura bichenovii*) from Japan: 3 green jungle fowls (*Gallus varius*) from Singapore; 2 nutmeg pigeons (*Myristicivora bicolor*) from the Philippine

Islands; 12 Galapagos penguins (*Spheniscus mendiculus*) from the Galapagos Islands; 3 blue honey creepers (*Cyanerpes cyaneus*) 8 cocks of the rock (*Rupicola rupicola*), and 40 silver-billed tanagers (*Ramphocelus bresilius*) from Brazil; and 12 tanagers (*Tangara guttata chrysophrys*) from Venezuela.

MAMMALS ENTERED

Importations of black bear cubs from Canada diminished considerably, permits being issued for only 96, as compared with 174 the previous year. Nearly all were consigned to New Jersey. Fourteen polar bears were imported from Norway, 3 Indian bear cubs from Calcutta, 2 Himalayan bears, and 1 Malay bear.

Monkeys in considerable variety were brought in, the rhesus monkeys from India alone numbering 8,200. There were several interesting species, including chimpanzees, baboons, colobus monkeys, macaques, and bush monkeys from Africa and India; and ringtails, marmosets, and woolly and moss monkeys from Central America and South America. One orang-utan was entered from Singapore.

Among the more interesting mammals imported for zoological gardens were 1 maned wolf (*Chrysocyon jubata*) from Santos, Brazil, for the National Zoological Park, Washington, D. C.; and 1 aard-vark (*Orycteropus afra*) from South Africa, also for the National Zoological Park. Both are exceedingly rare in captivity.

PERMITS ISSUED UNDER MIGRATORY BIRD TREATY ACT

The regulations under the Migratory Bird Treaty Act provide for the issuance of permits to take, possess, buy, sell, exchange, and transport migratory waterfowl for propagation; and to take, possess, buy, sell, exchange, and transport migratory game and nongame birds for scientific purposes. The number of such permits outstanding at the close of the year, including permits issued during the year, was as follows: Scientific collecting, 2,350; scientific possession, including taxidermist, 574; special scientific possession, 1,624; bird banding, 1,874; and propagating (possession and sale), 4,398.

To take migratory waterfowl for propagation, 114 permits also were issued. Reports submitted by permit holders during the calendar year 1933 show 47,102 wild ducks raised in captivity, of which 45,422 were mallards and 879 black ducks, and the others mainly wood ducks, pintails, teals, gadwalls, canvasbacks, scaups, shovelers, baldpates, and readheads. The number of wild geese raised under permit was 4,166. Migratory birds propagated and reported sold during the year included 5,281 ducks and 251 geese for food, and 5,055 ducks and 1,742 geese for propagation.

OPERATIONS IN PREDATOR AND RODENT CONTROL

In many respects the fiscal year 1934 was the most turbulent and most unsatisfactory in the history of the Bureau's predatory-animal- and rodent-control operations. Federal expenditures were cut from $547,499 in 1933 to $418,304 in 1934; State expenditures from $370,794 to $248,044, and the cooperative funds of counties, livestock associations, and others from $641,785 to $615,082. Revenue for predatory-animal control, derived from State levies on livestock, had fallen off as much as 75 percent in 3 years because of the decrease in assessed valuations. The price of furs continued too low to attract the commercial trapper, and the burden of controlling predators was left to the entirely inadequate force of Federal and cooperating hunters. In spite of the excellent showing made by these hunters the previous year, predatory animals had increased alarmingly, and as their depredations on stock and game increased, so did the requests for assistance. Even the weather aggravated the situation, the extreme drought causing injurious rodents to concentrate on the greener cultivated crops, and both livestock and predators to gather around the comparatively few watering places.

For more than 20 years the Biological Survey has conducted an uphill fight to gain control over the rodents that have so greatly interfered with western farming and grazing. Slowly, but surely, they have been suppressed, until in recent years this major hazard has been reduced over large areas. The fecundity of the rodents is so great, however, that much of the advantage gained is lost by relaxation for even a single year. The threatened relin-

quishment of the hard-earned advantage was thus of the utmost concern, both to those responsible for local projects and to the cooperators who depend upon the Bureau for leadership. The resourcefulness and courage with which this situation is being met is a tribute to the character of the men engaged in the work. To compensate for decreased personnel, the trappers employed lengthened their trap lines, the rodent crews pushed their operations to the limit, and in many cases curtailed appropriations were offset by funds raised by stock associations. In Nevada, for example, following the elimination of the State appropriation of $17,500 for predatory-animal control, the livestock associations were asked to pay half the salaries of the Federal hunters in their district and more cooperation was pledged on this basis than there were Bureau funds to match.

Fortunately, emergency funds were made available during the year, and in many cases these took the place of curtailed appropriations to the extent that in most districts rodent-control activities did not suffer and in others more progress was made than in any previous year. Although the emergency projects for predatory-animal control helped out materially wherever they were practicable, such emergency work cannot compare with the efficient accomplishments of the regularly employed hunters.

At the close of the fiscal year it was found that an all-time record had been made in the acreage treated for the control of field rodents (31,345,555 acres); and also in the extent of control operations directed against the house rat. Regardless of the reduced personnel, practically as many predatory animals were taken this year as in last year's record catch.

CONTROL WORK UNDER THE RECOVERY PROGRAM

Designed to give work to unemployed, the recovery program sought to meet the greatest public needs, and in many States programs of rodent and predator control were selected as major projects. Through emergency projects 10,758,072 acres of national forest, Indian reservations, and other lands were treated in the suppression of injurious rodents.

Rodent control fitted well into the recovery program, in that it provided employment for a large number of men without the necessity of expensive equipment and supplies, other than for bait materials. Furthermore, much of the bait used (1,748,873 pounds) in these emergency operations was prepared in the Bureau's bait-mixing station at Pocatello, Idaho. Efficient results have been obtained, largely due to the large corps of capable operators who had been developed in previous years and were thus available for supervisory positions.

CIVIL WORKS, FEDERAL EMERGENCY RELIEF, AND RECONSTRUCTION FINANCE CORPORATION PROJECTS

The largest emergency project conducted by the Bureau during the year was C. W. A. project F–17, "Rodent control in connection with typhus fever control." This was carried on in Georgia, Alabama, and Texas in cooperation with the United States Public Health Service and had as its prime objective the control of typhus fever. Fleas from infected rats transmitted the virus to other rodents and to man. To control the disease it was necessary to eliminate the rats.

Approximately 10,000 C. W. A. workers were employed in treating 747,608 premises in the 3 States. The use of more than 800,000 pounds of red-squill rat bait and 400,000 traps resulted in the destruction of at least 7,500,000 rats, at a total cost of $672,962.82. It is still too early to know the ultimate effect of the campaign in the control of typhus fever. The number of typhus-fever cases had increased 300 percent in Alabama during 1932 and 1933, and in 1934 up to the conclusion of the rat-control campaign, and had the same ratio been maintained 630 cases would have been reported from the close of the campaign in March to July 1. Instead there were only 47 cases, or an indicated decrease of 93 percent. In Georgia and Texas a corresponding decrease in the number of cases also took place. The economic saving of produce and property in the 136 counties covered has been estimated to be approximately $8,750,000.

A number of additional local C. W. A. campaigns for the control of rats were conducted—primarily in Texas, Mississippi, and New Jersey.

The C. W. A. program (continued after March 31 as F. E. R. A. work) was utilized in predatory-animal control operations in Arizona, Colorado, Montana, Utah, Oregon, Washington, and Wyoming. R. F. C. funds were made available in Texas for the control of predators. A total of $85,310.47 was expended on these projects, accounting for 7,314 predatory animals.

PUBLIC WORKS PROJECTS

Of $296,100 in P. W. A. funds allotted to the Bureau by the Forest Service for rodent control on national forests, $185,700 had been expended by the end of the fiscal year and 4,453,138 acres of national forests had been treated for the control of prairie dogs, ground squirrels, kangaroo rats, pocket gophers, and porcupines. The bulk of this work was accomplished in Oregon, California, Idaho, Nevada, Arizona, Colorado, Wyoming, New Mexico, and Utah. The direct allotment of P. W. A. funds to the Bureau made it possible to carry on work that could not be reached by E. C. W. crews working out of C. C. C. camps. P. W. A. labor was also used to follow up E. C. W. work done last year and to treat extensive areas of forest preserves where previously work had not been possible. The cooperation of the Forest Service was of great assistance in the efficient expenditure of these funds.

EMERGENCY CONSERVATION PROJECTS

Labor from C. C. C. camps of the E. C. W. program was utilized on 5,682,230 acres of Indian reservations, forest preserves, and other public lands for the control of ground squirrels, prairie dogs, jack rabbits, pocket gophers, porcupines, and other rodents. Regular employees of the Bureau were transferred to the E. C. W. rolls as supervisors in many cases, and in other instances Forest Service officials in cooperation with Biological Survey leaders supervised the operations. Damage by pocket gophers, rabbits, porcupines, and other rodents to forest plantings made rodent control important in reforestation. Control of burrowing rodents also became a necessary adjunct to the erosion-control program. Under this program limited predatory-animal-control work also was conducted in New Mexico and South Dakota.

OTHER EMERGENCY PROJECTS

With $15,000 of drought-relief funds set aside for rodent control, 368,844 acres were treated in Idaho. Other emergency funds were made available in small amounts, such as P. W. A. money for local projects in California counties and R. F. C. funds for predatory-animal control in Texas.

ECONOMIC BENEFITS FROM PREDATOR AND RODENT CONTROL

Increase in the numbers of predatory animals following the cessation of commercial fur trapping considerably augmented the losses from the predators this year. For instance, their destruction of sheep in Arizona has been estimated as 3 percent among the flocks on the ranges and 0.5 percent among calves. In Texas the State's estimate of loss is much lower, being 0.75 percent of sheep, 1 percent of goats, 0.5 percent of pigs, one-fortieth of 1 percent of cattle, 3 percent of chickens, and 7.7 percent of turkeys.

Because of the protection given bears in several States and because of a shortage of natural food, in places their depredations have been on the increase. As an example of the damage individuals can do when they become killers, one bear during the year killed 135 sheep in Mineral County, Colo., before being captured. It was found necessary to take 347 stock-killing bears during the year, as compared with 242 last year. In the entire 20 years of predatory-animal control the Bureau has taken only 3,464 bears throughout the United States, which is no more than the number that has been taken in a single year by hunters on the national forests alone.

The beneficial effect of predatory-animal control upon game conservation is becoming increasingly evident. Antelope in particular are increasing rapidly in localities where predator control is maintained. In Nevada, Oregon, and California their increase has been largely due to the protection afforded by Bureau hunters. In 1920 the antelope had reached a low ebb, but since the beginning of the control work in 1915 hunters stationed on and about their range in the present Charles Sheldon Wildlife Refuge have removed 2,991 coyotes

and bobcats from the area, and the approximately 200 antelope on this range at the beginning of the control program have increased to a herd numbering 1,000 to 1,500. In 1921 a hunter was stationed in the Mount Dome section of California to keep down the animals preying on the antelope, which at that time numbered less than 100. Since then 3,078 coyotes and bobcats have been removed from this range, and the herd has increased to about 900. In Oregon, on the Hart Mountain area, hunters have removed 1,526 coyotes and bobcats from the antelope range, and the herd ranging on this and adjoining areas has increased from a few hundred to between 3,500 and 4,000, and there has been a surprising increase in the number of mule deer on this area. That deer and turkeys also respond rapidly to protection is evidenced by a report from Texas that the numbers of these game species have at least doubled since predatory-animal-control work was begun there 6 years ago.

Although predators in general have increased during the past 2 years, they are scarce in comparison with the numbers prevailing before the Federal control work was instituted 20 years ago. The present maximum infestation is probably reached in southern Texas, where 12,920 coyotes, 2,567 bobcats, and 66 mountain lions have been taken in Webb County alone in 2½ years. The control of wolves has been satisfactorily maintained, and definite headway has been made in Michigan, Oklahoma, and Arkansas.

Estimates of the value of rodent control have been made by farmers and stockmen on whose lands the work has been accomplished, and the figures have been compiled by projects and counties by the Survey's district leaders. The total savings thus effected on 31,000,000 acres during the past year is estimated at $6,878,000, exclusive of the savings resulting from rat control in the typhus-fever campaign, which is estimated to have been an additional $8,750,000.

DISEASE CONTROL BY SUPPRESSION OF CARRIERS

No serious outbreaks of rabies in wild animals occurred during the year, Federal hunters in several States having suppressed sporadic outbreaks before they became wide-spread. Rabies among coyotes in Reeves and Culbertson Counties, Tex., caused the death of a number of cattle, bitten before the outbreak was brought under control by concentrating a number of hunters in the area. By capturing the last of the infected coyotes, a definite stop was put to the serious rabies epizootic that appeared in New Mexico during the last fiscal year.

A serious outbreak of bubonic plague among rodents in Modoc County, Calif., is indicated by positive determinations in more than 20 Oregon ground squirrels (*Citellus oregonus*) and 1 wood rat (*Neotoma cinerea occidentalis*). Arrangements are being made for control operations when the rodents emerge from hibernation next spring.

The death of more than 200 sheep near Ringling, Mont., resulted in an investigation by specialists of the State board of health, the Rocky Mountain Spotted Fever Laboratory, and the Bureau of Biological Survey, who definitely determined that tularemia was responsible, the infection having been transmitted from rabbits to the sheep by ticks. Examination of rabbits, which were dying in this vicinity, showed that they were infected with the disease. Losses stopped after the sheep were dipped and moved to a new range. The Biological Survey inaugurated a control campaign to reduce the number of rabbits.

CONTROL OF HOUSE RATS AND OTHER RODENTS

Operations for the control of house rats, other than in connection with the emergency program, were conducted in a number of Western States, particularly on the Pacific coast, and in Texas and States east of the Mississippi River. The number of rat-control campaigns, however, declined sharply from the number last year because the time of county agricultural agents was so fully taken up with the agricultural-adjustment program. In addition to the emergency work, 89 county and city rat campaigns were conducted in the East, utilizing 29,430 pounds of bait on 16,828 farms and other premises.

Red squill as developed by the Bureau is being used more widely each year for the control of house rats and is rapidly replacing more virulent and harmful raticides, thus reducing the menace of poison to human life and domestic animals. By means of a scholarship financed by the Massachusetts cooperative

rodent control fund, the second year of a study of red-squill extracts has been completed at the Massachusetts State College, and as a result red-squill extract is now being used as a follow-up to powdered red-squill baits.

In field-mouse control 52,647 pounds of bait were used. Many demonstrations also were made in the control of woodchucks, moles, cotton rats, and other rodent pests of purely local importance.

During the rush season it was found necessary to operate the Survey's bait-mixing station, at Pocatello, Idaho, daily on a 24-hour schedule in order to meet the needs of E. C. W., P. W. A., and F. E. R. A. rodent-control operations in addition to the regular work of the Bureau. As a result of capable management, 2,735,953 pounds of improved grain bait were prepared at this plant during the year and shipped to 25 States.

CONTROL-METHODS RESEARCH

Improvements in methods of controlling predatory animals and rodents were made at the control-methods research laboratory, at Denver, Colo., and at field stations. As there is a wide variation in food preferences of the same species in different localities and at different seasons, as well as great discrepancies in susceptibility to strychnine and other poisons, hundreds of combinations must be tested in the field in order to find the formula best adapted for a typical habitat. Seventy-seven processed strychnine formulas were prepared and tested this year. Several of these gave better results than the old standard formulas and were used to advantage in extensive field operations against prairie dogs and ground squirrels.

Other work at the Denver laboratory included 160 analyses and tests of stomach contents and of organs of animals accidentally poisoned, and toxicological and chemical tests of commercial poisons.

Seasonal food preferences of pocket gophers were studied in California, Oregon, and Arizona. New poisons are constantly being studied, and the most promising are given comparative field tests. Zinc phosphide has been found most toxic to wood rats, a species highly resistant to strychnine.

Though the relation of rodents to reforestation problems has long been studied, the tremendous increase in tree planting under E. C. W. necessitated intensive research to develop methods for the protection of seedlings from mice, ground squirrels, rabbits, and other rodents. Bureau workers successfully developed a formula and method of application for attacking the problem, and control operations were well started before seed planting was undertaken. On the unpoisoned areas a great deal of damage was done by mice, while on the treated areas, there was relatively little injury. No clipping damage of any consequence has occurred to the seedlings since they have sprouted.

In the Northwest and in the Lakes States region, extensive work has also been done on methods of controlling snowshoe rabbits as they affect the tree-planting program, and satisfactory progress toward control on these areas has been made.

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